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SOME CONCEPTS OF JOB FAMILIES AND THEIR IMPORTANCE IN PLACEMENT

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THERE are, it is asserted, some 30,000 or more occupations. That is a large number. We could hardly construct that many aptitude tests, say, in a century. To any other proposal affecting all the occupations one would have to make a similar comment. The task is too big; it would not get done. There is great need, accordingly, for somehow reducing the number of "kinds" of occupations. Could one sort out, for example, a small number of type-occupations which would stand for or represent the lot of them?

This hope is analogous with the corresponding dream of psychologists regarding human types. They hope to be able to type all humanity into a relatively few "unique personality profiles," or patterns. Thus, though the people in a given type still would differ considerably amongst themselves, such differences might be thought of as relatively unimportant. The people of a given type, however, by definition would be singularly alike in, say, such matters as aptitudes, health, drives, wants, and satisfactions. They might still differ greatly in race, color, religion, height, weight, appearance and other respects.

The importance of such maneuvering is easily seen. For example, in any psychological, sociological or educational study, "like persons" must be subjected to the test of the experiment. With only a limited number of types of people to be concerned about it would be easy then to get together

[1] On leave with the National Scientific Roster of Scientific and Specialized Personnel. The writer is indebted to Dr. Beatrice J. Dvorak, who made consultation with WMC officials possible, and to Dr. Carrol J. Shartle for helpful criticism of the article in formulation.

enough persons for a study; enough that any statistical follow-up would be statistically reliable. Without some such conception as "unique personality profiles" every person obviously has a profile so "complex" that he is his own type, thus resulting in 140 million such types in America, and no studies are possible.

Just as the botanists find it useful to group their plants for study, and the zoologists their animals, so must psychologists find a way to group their humans. How to do this is the question. This they may not do by employing the United States Census classifications. The psychological differences, for example, are small between whites and Negroes; between men and women; or the single and the married. We must search deeper for the more fundamental differences among individuals, indeed for the traits which are the "basic dimensions" of humans.

The traits on which unique personality profiles are founded must be chosen—it is known—to obey such general principles as:

1. The traits must measure basic human "dimensions" or qualities. Another way of saying the same thing is to state that:
    a. The traits, in the aggregate, must correlate highly with success in all the important endeavors of mankind, particularly the occupational success criteria.
    b. They must correlate zero, approximately, with one another to the end that each such trait thus measures as much as may be something different from every other, a basic human "dimension."
2. The number of such traits to be measured will therefore become a minimum; and the "minimum profile of personality" results.
3. The traits must be objective and quantitative, and (preferably) not too expensive of time or resources for their accurate measurement; in a word, they must be capable of being measured by practical tests or measuring instruments.

Obviously analogous concepts underlie any attempt to classify occupations. The "traits" of occupations likewise must pass the same standards. They too must be unique, minimal in number, and as objective, quantitative and practical as possible. There is here, however, an additional requirement, popularly referred to as a means of "bridging the gap between the man and the job." Briefly this means that, if possible, the occupation should be measured in the same units as the man, to the end that we may form reasonable judgments of whether this given man can do this particular job; or rather, since the man is the reference point rather than the job—or popularly, since industry exists for man and not man for industry—which job, of the myriads of jobs, can a man of this particular profile in general do best? The reference point often is reversed, and particularly in wartime where filling the "openings" is the paramount consideration, even though it does not follow in every case that the individual "works at his highest skill." War is an emergency; it is met with emergency behavior. Thus in wartime we may find it desirable and necessary to employ practically all 24-percentile, or higher, chemists as *chemists;* but we also may employ even 100-percentile lawyers as clerks or infantrymen. (The professed aim of course is not to do this, but, after all, any soldier is *one* soldier!) With peace, the guidance consideration will again assume its former relative importance.

With humans and jobs measured in comparable units, and having amassed in addition a very abundant evidence upon the efficiency of each given type of man in each given type of job, very vigorous modes of sorting men to fill jobs (for selection or placement) and of sorting jobs to suit men (for guidance) at once become possible. The technical problems therein are at least partly solved. With the two measurement problems solved, the problem of measuring the correspondence would readily yield to attack.

Hitherto this correspondence of job and man has been "decided" by a counsellor, employment clerk or placement officer, customarily all too ignorant of the varieties of human nature, on the one hand, and of the varieties of jobs on the other. And

customarily he has thought of the job as a different-order-of-creation, with its own traits and categories that bear little or no relation to human traits and categories. Clearly then any mode of classifying occupations and jobs which will emphasize such values and relationships—particularly any which will make the relationship obvious—will be valuable and likely will lead both to better selection (placement) and to better guidance. Ideally, if there could be a one-to-one correspondence between the occupational "traits" and the man traits, placement would be maximally facilitated. Possible methods of making this correspondence are considered herein. Briefly, they are:

1. Stating the requirements of the occupation in terms of the average or, preferably perhaps, the 75-percentile as-to-success worker therein, on the traits on which it is useful—i.e., valid—to measure the workers.
2. Specifying an occupation as an idealized set of human requirements, or profile of human traits, based on human judgments of the occupation's "requirements."
3. Specifying all occupations in terms of the human traits which a factor analysis of data, obtained preferably by method 1 above, would reveal as the common measures of all jobs.
4. From empirical observations of success on jobs of a very large number of men of varying profiles, specify as the human-characteristics profile of the job, that human profile which succeeds best at the occupation in question.

The attempt to classify occupations has so far led only to the concept of job families. The concept has grown out of employment office work, where in normal times they have on hand unemployed men needing work. Their search at such times is for an available job which a given man, say an accountant, can do. Their special knowledge consists in convictions of what a given type of man can do.

Our problem is to increase that knowledge and to amplify its dependability. During the depression it became obvious that an accountant could do labor work, if he had to, in order to live. Even depressions, however, do not greatly increase our knowledge of what *more complex* work accountants can do.

Clearly, if we could systematically accumulate such experience for all or most men of the community as they change jobs, we should soon have a vast fund of knowledge for sifting and refinement. In wartime many drafted men arbitrarily and by chance are placed in occupations new to them, but in most cases these too are down-grading; and furthermore, little record is made of the satisfactoriness of such placements. At such times much job-dilution (job-simplification) is resorted to in an effort to employ less capable talent on small units or specialized aspects of more complicated work, to improve production and to increase accuracy by the development of great individual skill on non-complex tasks.

It has long been known in employment office work that when industry could not get "exactly the type of man it wanted," a man of "certain specific occupations" often might do almost as well. In Swan's Index, for example, prepared for the C.C.P. personnel work of World War I, the "substitute occupations, or civilian equivalents," of some 750 Army trades and occupations were determined and listed for the use of all personnel officers. The problem, it has been stated, is that of how to transfer workers from job to job with the fullest possible utilization of their previous skills. Thus the Army should exploit the civilian occupational skills of the draftee, and in turn industry, after peace, should exploit the Army-acquired occupational skills of the demobilizee. Inasmuch as any definition is always defective, let us enumerate the possible characteristics of a "job family," by implication, from a consideration of the actual or proposed practical uses of such "job families":

1. When up-grading, training will be more effective if it is for a new responsibility which falls in the same family of occupations. Thus shortages of manpower may be readily filled from excesses of manpower if such exist anywhere in the same family of occupations. By such action the amount of re-training will be minimized. (It will be recalled that different occupations turn out different products and these are peculiarly affected, in wartime particularly, by the presence or absence of raw materials. Accordingly, "excess" of manpower may

crop up almost anywhere after every new governmental order or decree.)

2. For determining substitute occupations for individual employment purposes, where the additional training, if any, is to be afforded by the job itself, job families provide the necessary factual information. The greater job families, based on industries rather than occupations, enable wise decisions to be made in converting non-essential industries to essential industries, with a minimum of waste.[2] The complete present manning tables of a factory compared with the proposed manning tables of a new production schedule reveal at once the distribution of occupations freed and those necessary for operations after the conversion. Let the distribution of occupations released be abscissae (X) of a two-way table; let the proposed new distribution be ordinates (Y) of the same table. The conversion is effected then in the following series of steps:

2(1). Into the diagonals of the table, which have identical labels for each coordinate, are placed the several frequencies of persons who can be transferred directly without conversion, into exactly the same occupations. The personnel cards, or duplicates thereof, of these specific persons are then sorted from the total work-roster and are filed under the new manning categories.

2(2). In each diagonal compartment, form a ratio of the number thus obtained to the total number desired in each of the several occupations. Parallel this record with another of arbitrary indices of indispensability of the unfilled portions. By a study of these two ratios, giving weight to the importance of the new occupations in the scheme of production, and to salaries, training time, and possibility of obtaining outside trained recruits, establish an order for filling the new occupations. It would be highly desirable if this angle of the matter could be made objective and mathematically determinate.

2(3). Reduce the X-marginal frequency, or abscissal marginal row of the chart, by the frequencies of persons just allocated (Step 2(1) without conversion).

[2] Shartle, C. L., Dvorak, Beatrice J. and Associates. "Occupational Analysis Activities in the War Manpower Commission." *Psychological Bulletin*, Vol. XL (1943), 703. Shartle, C. L. *et al.* "Ten Years of Occupational Research." *Vocational Guidance Magazine*, XXII (1944), 387–448.

2(4). Considering now the new occupation (Y) to be first brought up to strength: by aid of the job family classification pick out the *first* conversions therein, if any, those which in general can be made with a minimum of retraining. Add the frequencies of the corresponding persons to the compartment which is designated by an X of the to-be-invaded occupation and a Y of the to-be-established occupation, somewhere beneath the diagonal row of compartments; and remove a corresponding number from the X-marginal frequencies and also from the remaining roster the cards of those so related and converted. Similarly invade the other earliest-to-be-invaded occupations; and when all is complete establish in a second Y-marginal column the frequency of the most indispensable of the new occupations. If the quota is filled, the process is stopped short at that point, only enough persons being taken from the last occupation to fill the need.

2(5). In similar fashion, consider the second occupation to be brought up to strength, the third, and so on until all the possibilities of *first* conversions are exhausted, or until the quota is filled, whereupon the sorting of cards is at once stopped. But if this does not yield enough personnel, resort next to the *second* conversions, those requiring more training, and to the third and higher conversions, if any, until either the quota is filled or there are no more possibilities of conversion remaining. The several conversions may be kept separate by different colors of ink, and are a training order in detail to the training department: "You are to train so many lathe-hands to be assemblers, etc."

2(6). Consider next the second most urgent new occupation, repeating steps 2(4) and 2(5).

2(7). So continue until there are no more conversions to be considered.

There will now be two groups of interest:

A. A residue of personnel not useful to convert. If there are shortages in other areas of production, these may be subjected again to a second scanning with the end of filling these shortages.

B. Shortages in the proposed new manning tables which must be filled by resorting to outside recruitment.

Clearly there is room here for the development of mathematical methods of optimalizing placements.

3. Transferring an unsuccessful person within a firm into an occupation in a job family in which he had formerly been successful, as an alternative to separation from the firm, is wise personnel management.

4. In giving guidance to individuals who wish an improvement in their situation but are unable to forego an income while retraining, job families are helpful.

It is a well-known principle of adult guidance, for example, that if possible the guidee should exploit his most successful experiences and training rather than merely abandon them when he changes occupation.

5. In recruitment of personnel for new industries, job families inventories yield valuable information as to *where* such recruitment will yield the best results at the least cost.

6. In the assignment of recruits to related military occupations, job families prepared for the Army, Navy, Marines and U. S. Coast Guard have been helpful.[3]

7. That wages of the member occupations of job families, other things being equal, should differ but little, is a principle of value in wage adjustment.

8. The various occupations of job families probably have highly similar physical demands, thus making it possible to know alternative positions into which a given handicapped person will fit, without preliminary research or trial and error.

9. In promotions one wants to maintain the principle of individual growth, rather than that of revolution, so that a knowledge of job families should be helpful in establishing paths of promotion. One is ready for promotion when one is proficient in his present job in all the elements thereof that are common to the next job ahead, this assuming that the paths of promotion previously have been established according to such principles. One's present job is thus always a production field for exercise of the skills, knowledges and tech-

[3] Shartle, C. L. *et al., op. cit.*, p. 704.

niques obtained in the previous position, and a training field for acquiring those skills, knowledges and techniques basic to the production of the job ahead which also are a part of the reasonable practice of the present position.

10. In aptitude test construction, a test conceivably may be devised which will be reasonably adequate for all the occupations of a job family, thus restricting and constricting the field a great deal.

11. The reabsorption of veterans and the shift of civilians from wartime production to peacetime production after peace and the demobilization will involve a stupendous task of worker transfer, retaining and allocation. As an aid in this task, job families, applied in reverse, will be useful to locate the logical job destination of workers in civilian industry when war and war industry no longer exist. In theory this is analogous with the construction of a decoding code. Inasmuch as it is reasonable to believe that many demobilized at peace will be ready for promotions, their after-war destiny logically also should be a related job-family occupation to which a given worker "should be promoted" in view of his increased "skill" acquired during the war years. The longer the war, the less advisable it is for a larger and larger number of the demobilizees to return to their former jobs.

The common statistical element in all the above uses of job families is that a few "type" jobs may stand for all jobs just as a few personality profiles may stand for all human profiles. The end to be secured is a great reduction in the magnitude of the problem and in the amount of data or evidence which must be obtained to solve a problem.

The War Manpower Commission says that there are six classes of requirements[4] on which occupations should be compared, namely,

(1) Nature of the work done.
(2) Tools, machines and other aids employed.
(3) Materials worked upon.
(4) Traits required of the worker.
(5) Knowledge (including specialized knowledge) required.
(6) Experience.

[4] Stead, W. H. and Shartle, C. L., *op. cit.*

Occupations grouped on the basis of the work performed (i.e., sorted on the basis of action verbs, such as welding, sewing, nailing, gluing, etc.) seem more alike than if grouped on any other basis. In the United States Employment Service sorting of the "traits of occupations" to determine the job-families, the first four of the above list occur in the order above named in the sorting operation. Shartle's results seem to show that "people," rather than specific kinds of people, are required for a majority of the occupations of industry, and that the training time is, for the great majority, unbelievably short. Wartime training methods of unusual potency emphasize the correctness of this conclusion. Motivation was often at a maximum. If you did not learn, you got your head shot off!

As a means of facilitating their use, the coding scheme employed to stand for an occupation should take into account the family relationship of occupations by ascribing contiguous numbers to the highly related occupations. Occupations thus break down into "fields of work," somewhat narrower "process groups" and, finally, into still further variations, varieties, alphabetically arranged (and distinguished by unit digits in the USES code number).

Just as in the taxonomy of botany one may arrive at various conceptions of what is a "family" (a sub-division of higher divisions of classification) so one may arrive, by different routes, at different classification principles, at different aggregations of occupations which in the several classification systems logically may be called families. Some half dozen such alternative, actual or potential systems of deriving families of occupations will now be outlined.

1. The most extensive development of job families has been made by the technique developed by the WMC, Worker Analysis Section. It involved the following steps:

1(1). A job characteristics form, consisting in its final edition of 47 human traits, was filled out by from one to fifteen analysts in different parts of the country observing the same occupation, as distinguished from job-in-this-particular-factory.

1(2). The same analysts also observed the duties of the

worker, the tools used, the equipment, the materials and the minimum education and experience necessary for the work. The results were systematically recorded in a Job Analysis schedule form.

1(3). A compromise set of "traits" for the given occupation was decided upon, and was entered into a Master Worker Characteristics Sheet.

1(4). The results now were recorded into Speedsort cards and other pertinent observations about the occupation were written on the face of the card.

The cards now represented in highly condensed form the results of judgments of what are the important characteristics of the occupation in question. Some 9,000 occupations, in some 85 industries, were thus reduced to Speedsort cards, a kind of catalog of occupations which could ultimately, after the job is finished, become *the* card catalog of American occupations. By the aid of the usual sorting needles, presumable families, having regard for the above list[5] of judged most-important "traits," were sorted out. This was aided by noting that as the sorting progressed, channels in the edges of the cards began to develop on other traits of a family than in those traits actually sorted upon, the traits of the list above. Aided by these, the member-occupations of presumable job families were sorted out.

The complete job analysis description was appealed to as a further test for excluding some of the presumable members of the family; and to insure that all that should belong to a family had been included. The job family was now complete.

1(5). There was still a need for ascertaining which of the members of the job family were most like the ideal "job type" from which all the occupations of a family deviate in some respects, even "important" ones. By a highly subjective procedure, based first on a guess as to the relative importance (weights adding up to 100) of the half-dozen or more generalized aspects[5] of the type occupation, and second, upon the subjective points-rating therein of a given occupation, never

[5] The aspects as above outlined are: (1) work done; (2) tools, machines and other work aids used; (3) materials used; (4) worker characteristics required; (5) experience required; (6) training (including *special training*) required.

exceeding the previous "weight" of this particular member-occupation of the job family, there was ascertained an aggregate numerical value (the sum of the points-ratings) by means of which the specific occupations could be ranked in a decreasing order of degree of resemblance to the type job.

By aid of these, the job-family was split into three subdivisions:

> Closely related occupations—those in which workers of experience could probably be transferred to any other member-occupation of the closely related group with little or no retraining.
>
> Less closely related occupations—those for which workers required more retraining to make them acceptable workers.
>
> Least closely related occupations—those barely meeting the minimum requirements for useful similarity, and for which workers, although they might require complete retraining, nevertheless because of their worker characteristics and other considerations of knowledge, skills, etc., would be more likely to succeed at the work than just anyone chosen at random.

The apparent strong points of the method are:

a. A wide variety of "traits" of occupations was investigated.
b. The analyses of the job were made by trained analysts.
c. Observations of the same occupation were made in different parts of the country so that sectional discrepancies could be allowed for, even to the extent of splitting up an ostensible occupation into two or more; or it could be noted that occupations bearing differing names in different parts of the country are in reality one occupation, not several.
d. A common denominator of the several alternative analyses was decided upon.
e. The job families resulting had other than statistical and logical definition and justification, since the sorting of the Speedsort cards was augmented by a

critical scanning of the entire description of the constituent occupations before adoption.

Its more obvious weaknesses are:

a. The analyses were subjective, even though done after a uniform schedule or outline.

b. The list of job "traits" was not wide enough to cover adequately the professions.

c. The comparison of the reports of the as many as fifteen analyses of a given occupation was done centrally by a person out of touch with the field and without giving the analysts who did the work a chance to correct the most obvious misconceptions. The completed analysis was not generally sent to them for criticism before official adoption, although some one or more analysts scanned each of the proposed analyses before adoption.

d. Different Speedsort operators, with the same end in view, presumably could come up with different potential job family-occupations. In other words, the system was not fully statistically determinate.

e. There is some doubt whether the skills and traits of workers are in every instance transferable merely because the pattern in the Speedsort cards is highly similar. A watch-maker and a cannon-barrel borer might come out in the same job family and on the basis of the statistics have every warrant for belonging to the same family, yet the psychological characteristics, particularly as to precision, may be quite different so that actually there is little transferability of skills.

f. The double dose of subjectivity involved in putting the sub-members of a job family in decreasing order of resemblance to the common type is unfortunate when there exist several alternative techniques, independent of subjectivity, which will give a numerical measure of the degree of correspondence of two profiles. The ideal jobs or type jobs we take to be a pure figment of the imagination. It has no

more objectivity than anyone's conception of the "ideal mammal," the "ideal liliacea" or any other taxonomic classification. In fact it does not have the rigidity of definition of a sub-classification of botany in that *all* liliacea are spermatophyta (seed-bearing, with true roots, stems and leaves), angiosperms (with true flowers, each containing, normally, four whorls of floral organs), autophytic (possessed of chlorophyll), monocotyledonous (one cotyledon in each seed and with parallel-veined leaves) and bulbous (having bulbs).

2. Inverse factor analysis may be employed as an alternative means of ascertaining a job family. If the characteristics of an occupation can be quantified and measured, a factor analysis—occupations replacing the usual human names—will reveal what factors of job-traits underlie occupations in general. In this there is no necessary restriction of "the occupation" to any particular pattern of measurements, for these may be quite as broad as, or broader, than the WMC list above; and in the case of the professions[6] almost surely will be broader than that list! Occupations having similar factor loadings belong to the same family.

3. A variant on method 2 above emphasizes successful plying of an occupation and implicitly recognizes that every occupation has at least a fringe of people "who ought not to be in the occupation." If the various X's of the above method are replaced with a sufficiently varied list of the human traits of, say, "*successful workers*" of the occupations in question, the resulting factors will discover the basic human factors of workers. In this case also one may express the occupation in terms of its component factors and factor loadings. The loadings, here, are the profile of the occupation; and those occupations with highly similar profiles are jobs of highly similar human requirements. The occupations which resemble each other most comprise the job families.

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[6] Professions are generally characterized by a higher level of job-traits than characterizes occupations which are not professions; in particular in such respects as research, administration and supervision, and knowledge. There is probably no job-trait found uniquely among professions save that of being dubbed a "professional."

The occupations of a given job family presumably may be located after the occupational profile is obtained by such methods as 1 or 2, either by (1) the Sagebeer Index, or alternatively by (2) the Stephenson inverse factor method. In employing the Sagebeer Index, a rationale of research for locating families would need to be developed.

4. A fourth method might be dubbed the universal follow-up method. If one kept track of all or nearly all placements of professional personnel and at the conclusion (resignation, discharge, transfer) of the jobs of such personnel collected a simple verdict as to whether or not the person in question had been "satisfactory" in the position in question, one might analyze the resulting data to note by a simple correlation index which occupational transfers are successful and which are not. With all the occupations of concern appearing in alphabetical order as both the ordinates and the abscissae of a two-way table, one may let Y be prior job and X be subsequent job. In the compartments thereof, let four-fold correlation coefficients, solved by the formula,

$$r = \frac{ad - bc}{\sqrt{(a+c)\ (b+d)\ (c+d)\ (a+b)}}$$

be recorded. (See Fig. 1 below.)

Prior Job (Y) \ Subsequent Job (X)	Unsuccessful on subsequent job	Successful on subsequent job	Total
Successful on prior job	c	d	c+d
Unsuccessful on prior job	a	b	a+b
Total	a+c	b+d	N

FIGURE 1

Four-fold Validity Plot of Success on Prior Job and on Subsequent Job.
(If success can be more adequately measured than implied in the bifurcation illustrated, this four-fold plot would be replaced by an m × m-fold plot)

The letters of the diagram (Fig. 1) are the frequencies of the table, here recorded literally to show the mode of computation by the formula. From such a table of r-indices, by means of a suitable index to be devised, one could readily sort out the job families. It will be noted that one obtains here two-directional indices. Thus, not only would one consider the question "Are the failures of job A also failures when they subsequently enter B?" but also "Are the failures of B failures when they subsequently enter A?" If the two tendencies are vastly different, as in some cases they may be, we might discover here some preferred *sequences* of progression in acquiring vocational skills.

It is normal for wide-awake, alert human beings to take on more and more skills, including jobs and even occupations, as they develop and mature. We know little enough about the more complex end patterns characteristic of "the expert." One interesting question here is whether the expert usually is characterized by having acquired his complement of skills in an orderly progression. If the answer were in the affirmative, obviously one might similarly order the acquirement of skills of all people to very good advantage. This method logically requires that all the experience of a large community of occupations be amalgamated, say of a WMC area at least.

5. The logical or evolutionary concept of job families, described by Knott,[7] conceives that jobs which belong to a family are the variations which a specialized industry has evolved out of a simpler craft. Thus hat-making, cap-making, dressmaking and even baggage-making in common employ variants of the power sewing machine (both the tool and the corresponding skills), itself an invention superseding in turn hand-sewing. And typists, stenographers and secretaries are variants of the amanuensis or letter-writer who still plies his skills in countries where most of the inhabitants are illiterate. In such variants some retraining is needed before an individual successful in one mode of sewing may become proficient in another, but, obviously, *the retraining period would likely be much less* than if

[7] Knott, Edward E. "Job and Occupational Analyses." *Missouri State Employment Service*, April, 1941, p. 47.

a highly skilled operator in any one of such were to be trained into a highly skilled operator of, in general, any other job not included in the job family, say a lathe operator. Thus an index of what the educational psychologists call "transfer value" would seem to be at the heart of this concept, which is based on logical, that is economic, historic, or evolutionary, concepts of the mode of development of the occupation in question. Insofar as such families can be ascertained without the necessity of the empirical evidence of the #4 method above—empirical ascertainment of transferability[8]—the method serves usefully to restrict the field of inquiry but does not eliminate the need for the previously mentioned modes of study. There are sub-families within families and sub-sub-families within sub-families. These may be ascertained more surely by statistical analysis than by unaided observation. One strength of the method is that more than the one source of data, the customary field observation of jobs by trained workers, is insisted upon as necessary to a proper classification. (To properly classify plants, one must study paleobotany as well as botany.) With a set-up such as No. 1 or No. 2 above, the sub-occupations, members of eventual potential sub-family groupings, would be the Y's of a basic data table whereas the X's might be either (a) tools employed, (b) unit-operations employed, (c) motions, in the Gilbreth sense, employed, or (d) worker characteristics, or any compound of the several kinds of such components, or (e) any other of the WMC classes of observations. The subsequent analysis of the collected data would follow that of Nos. 1 and 2 above.

6. An alternative to all the preceding is that developed by Mr. Robert Shosteck and associates of the Roster of Scientific and Specialized Personnel, to meet the emergency in prospect in the sciences when demobilization occurs. It is simply that of writing to industrial experts employed in practical work, including the selection of scientific and specialized personnel, and

[8] Evidently the indices of success of the basic table of the No. 4 method might be replaced by indices of amount of trainability required, say the average of retraining actually administered, it being assumed that retraining is stopped as soon as proficiency is achieved.

asking them to give their judgment as to the degree of transferability—on a scale:

1. *Considerable* transferability	(Less than six months additional training required)
2. *Moderate* transferability	(Six to twelve months additional training required)
3. *Slight* transferability	(Over twelve months additional training required)
4. *No* transferability	(Transferability unfeasible, since little or no training time would be saved)

—of people in a given series of occupational specialties of, say, civil engineer, when and if these were to enter the break-down specialties of the same occupation or the specialties of another industry, say the engineering specialties of municipalities. The present hypothetical occupations of the to-be-released workers are Y-ordinates of a two-way table, while the X-abscissae are the jobs of an engineering sort now maintained in municipalities. In this case, hydraulic engineers, for example, were asked to judge on the above scale the transferability of each of a number of kinds of civil engineers to the several other specialties of the same occupation. The validity of the method hinges on the ability-as-judges of the addressees, i.e., upon such factors as the extensiveness of their actual knowledge and experience with the implied situations judged, the criticalness of their judgment, and their willingness to take the necessary time—all of which could no doubt be brought to a state of excellence by well-known techniques, such as that of using lesser experts to pick the greater, and the like. The method has the merit of quickness, low cost, and independent verification of the observations exploited. It has all the weaknesses of using untrained judges in what is essentially a psychological experiment. It may be pointed out that the WMC job analysts also employed judgment, of small elements of an occupation to establish a profile from which, by statistical manipulation, the job family ultimately was determined and the transferability of skills was inferred. Here, however, the transferability of the specialty as a whole is judged. By abstract psychological principles the judgment required here is easier to obtain but

is of lesser validity than judgment of the more specialized sort obtained in the former studies. For the aid of demobilization counsellors, the less costly method yields results which presumably are about as fine as demanded for the purpose. The finer break-down of the WMC job analysis obviously enables more uses to be made of the results, such as advising the demobilizee to know what specific education or training he should acquire for a better all-round fitness in his new vocation. This the Roster technique, with its present paucity of data on the individual profession, cannot supply. However, having helped the demobilizee to choose wisely a new occupation which will exploit his army and pre-army training, such additional (educational) information in many cases may be had even more usefully from a new counsellor, perhaps a dean or secretary of an engineering college. The advisee is less condemned by receiving only parts of the truth than by receiving mistruths. If the validity of the method is equal to or only slightly inferior to the more laborious method, obviously then, on this score alone, it has great merit. Incidentally the statistics of ratings, for subsequent treatment of the results, are already well worked out. The necessary statistical indices in no case are an insuperable element of the whole. The rating scheme for rating officers' traits in World War I was deemed a rating failure by its chief statistician.[9]

Confronted with such a variety of actual or potential techniques, one feels a need to inquire, "Which is best?" The question implies the existence of some standard, some criterion, by means of which one might adjudge relative merit. Insofar as any such system is, from one angle, merely a filing or classifying system, obviously all the systems solve at least minimally the problem in the sense that every occupation has a position, and a code number, and none is omitted. However, a classification system may do and usually does do more: it leaves gaps to be filled in by variant and newly emergent classes. For some purposes the gaps may be quite as important as the filled niches.

[9] Rugg, H. O. "Is the Rating of Human Character Practicable?" *Journal of Educational Psychology*, Vol. XII (1921), 425–438; 485–501; *et al.*

The common purpose of job families, if the multitude of purposes enumerated above can be subsumed under one general statement, is that of ascertaining the paths of transferability of occupations in accordance with the need for the minimization of retraining. It is by this criterion then, if we are willing to accept it, that the competing methods must be judged.

The above statement implies a mathematical function which may be minimized (or maximized, according to its setup), a matter which is at once both the delight and the despair of the statistician. Suffice it to say, at this stage, that the best elements of all the methods likely will yield a better result than blind adherence to any one alone. In addition it must be pointed out that the statistically most elaborate system, the WMC system, was worked out primarily for the list of occupations job-analyzed in the course of the field observations which were paralleled by the development of the Occupational Dictionary. Only a very few professions were so analyzed. The implications of this will need to be thought through in arriving at a conclusion as to the potential values of this interesting new "measurement" device. Only a complete analysis of the entire problem, including the method of "bridging the gap between man and job"[10] (the coding, Hollerith sorting, and placement philosophy and practice) will reveal what elements, if any, are worthy of adoption. This statement would emphasize highly[11] also capacities and training (or education) to the point of specially mentioning them as well as skills.

It has been suggested that the study of occupations is a new social science.[12] Statisticians have long known that occupation, correctly ascertained—which the United States Census does not even pretend to do—is probably the most basic classification of mankind; of greater human concern, generally speaking, than race, color, sex, marital condition, education, age or place

[10] One simple solution to this problem is to say, "This job requires a man to grind *valves;* this man can grind *valves.*"

[11] Shartle, C. L. *et al.* "Establishing Families of Occupations." *Vocational Guidance Magazine,* Vol. XXI (1944), 405–414.

[12] Kitson, H. D. "Occupationology—A New Science." *Occupations,* XXII (1944), 447–448.

of residence. These categories have the force of tradition behind them; but they are not as basic, psychologically, sociologically or economically as is vocation. Economically all other human values directly or indirectly stem out of or are obligated to vocation. In correctly classifying occupations, then, we are making possible not only accurate studies of this all-important institution but also are laying the foundation for gaining a control of such matters as guidance, promotion, transfer, and the conservation of human talent generally. A statement about one aspect of the matter will make clear the importance of the matter. If a worker before changing his occupation knew with a high degree of certainty whether a proposed change likely (i.e., on the average) would result in greater opportunity for him, or the converse, much human loss and unhappiness could be prevented. Again, assuming a comparable development in human traits, if one knew what was the actual distribution of wages in two occupations for people of identical trait profiles, the present unjustified discrepancies would tend, without artificial restraints, shortly to disappear. And if, finally, a similar distribution of happiness-scores (on a test of satisfactions, often called morale in the Army and industry) could also be attached to the individual profiles in the above table any individual knowing his own profile could choose his occupation so as to meet his need, whether for a greater income, greater happiness or satisfaction, or both.

The lower the prestige of one's occupation, in a scale of prestige values, the more a man expects, normally, to get his satisfactions outside his work. In the professions one's work frequently is both one's vocation and one's avocation and recreation. To maximize the individual's salary and job-originated satisfactions is one of the crucial steps in the maximization of manpower.

REFERENCES

1. Davis, Edwin W. "A Functional Pattern Technique for Classification of Jobs." *Contributions to Education No. 844.* New York: Bureau of Publications, Teachers College, 1942, p. 128.

2. Carter, Harold D. "Vocational Interests and Job Orientation," *Applied Psychology Monographs,* Vol. II (1944), 85.
3. Dvorak, Beatrice Jeanne. "Differential Occupational Ability Patterns." *University of Minnesota Employment Stabilization Research Institute,* Vol. III (1935), 46.
4. Paterson, Donald G., Gerken, C. d'A., and Hahn, M. E. *The Minnesota Occupational Rating Scales and Counselling Profile.* Chicago: Science Research Associates, 1941, p. 133.
5. Trabue, M. R. "Occupational Ability Patterns." *Personnel Journal,* Vol. XI (1933), 544–551.

TESTING FOR ADMINISTRATIVE AND SUPERVISORY POSITIONS

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THE field of testing for administrative and supervisory positions is one which is approached by many psychometricians with a feeling of defeatism. A number of studies have been made to determine which testing methods will improve the selection of administrators and supervisors but, in general, psychometricians have tended to stay away from this phase of testing. The reasons for this situation are well summarized in Dr. L. L. Thurstone's statement:

> The intellectual and temperamental qualities that insure success in administrative work are probably more complex than almost any other group of abilities that can be thought of. Psychologists who investigate fundamental human traits would undoubtedly seek to investigate first those traits which can be assumed to be less complex.[1]

Although the complexity of the task of experimenting in this field is recognized, there still exists in industry, in the Army and Navy, and in government, the problem of selecting persons for supervisory and administrative positions. With a labor force, both civilian and military, of about 60,000,000 in the U. S., one can roughly estimate the existence of about 2,000,000 supervisory or administrative positions. There has been little study of the validity of present selection methods for these positions, but the great interest of high administrative officials in improved selection devices is some indication of the lack of values in techniques in use at the present time.

The following are general definitions of supervisory and administrative positions. By a supervisory position is meant

[1] L. L. Thurstone. *A Factorial Study of Perception.* University of Chicago Press, 1944.

one which involves responsibility for the working conduct of, and the quality and quantity of work produced by, one or more subordinates. By an administrative position is meant one which involves extensive responsibilities for planning, organizing, directing, staffing, budgeting, and coordinating the work of an organization or part of an organization. The administrator in some cases performs no supervisory duties since he may act only in an advisory capacity, but he usually has the functions of a supervisor in addition to his administrative duties.

Supervisory positions can generally be classified on the basis of three factors: (a) the number of employees supervised, (b) the nature of the work or the occupation supervised, and (c) the supervisor's level in the organization. It is reasonable to present the hypothesis that the skills and abilities required to supervise a few employees are different in degree, and perhaps in kind, from those required to supervise hundreds of employees. For example, the supervisor who likes to check carefully and in detail the work of a few subordinates may be successful, but this same action would probably make him a bottle-neck if he applied the same method to the supervision of a hundred employees. Observation indicates that this method is as much a trait of the individual as it is a function of the position that he occupies.

The nature of the work or occupation supervised is an important distinction between supervisory positions. The methods required to supervise a gang of ditch diggers successfully differ from the methods required to supervise a staff of skilled psychometricians. Some supervisors who have transferred from organizations where strict disciplinary methods were in use have failed miserably in attempting to apply the same methods on different occupational groups or in different work situations.

The trend in the field of administration has been to consider administration as an occupation *per se* and to emphasize the common elements among such positions. This trend has been especially strong in the field of public administration, it is noticeable in Army and Navy administration, and it is evident in the field of business administration.

Those opposing this trend claim that knowledge of the business or subject-matter of the organization that is administered is also important. Agreeing for the moment that administrative skill is more important than subject-matter knowledge, however, one can still classify administrative jobs into a number of categories on the basis of other considerations. These categories can be considered to be: (a) positions whose problems are of an international or national rather than local character; (b) positions involving the "selling" of the goals and objectives of the organization to an indifferent or even hostile clientele; (c) positions of an advisory rather than operating character; (d) positions requiring the ability to administer large and complex functions; (e) positions involving swiftly moving problems as contrasted with situations where speed is not so essential; and (f) positions involving the administration of a large organization with hundreds of thousands of employees as distinguished from a small organization with a few hundred employees.[2]

The above categories have been presented on the assumption that some of the skills and abilities necessary for successful performance vary according to these categories. Actually, these classifications are based on job analysis and it may be found that, in terms of testing, other categories may appear to be more significant.[3]

Qualifications

Before discussing actual results obtained in testing for supervisory and administrative positions, it may be worth while to present various opinions on the qualities necessary for successful performance in these positions. Dr. W. V. Bingham lists a large number of such qualities: the administrator doesn't

[2] These differences among supervisory and administrative positions, which are intended to be illustrative, indicate that thorough job analysis is extremely essential in testing work in this area and that the psychometrician should probably have the assistance of a person trained in administration to help him identify these differences.

[3] Cf. Alexander H. Leighton. *The Governing of Men.* Princeton: Princeton University Press, 1945. Leighton, who is a psychiatrist, in his study of a War Relocation Authority center, divided administrators into two groups: "people-minded" versus "stereotype-minded." His basic distinction between these two groups is based on whether the administrator puts emphasis on human values or on adherence to regulations.

go off "half-cocked," makes consistent decisions, has well-thought out policies, obtains real staff participation in the formulation of policies, builds a team, has ideas, listens to new ideas, is not an egotist, gives recognition for good work, delegates responsibility, sees his staff, has good timing in making decisions, and knows outside conditions.[4] Johnson O'Connor reports that successful executives have a large vocabulary, a wide range of aptitudes, an objective personality, an accounting aptitude, and an aptitude for their first position.[5]

Schell lists as the outstanding requirements for an executive an innate interest in and affection for people, an outstanding personality, and a scientific mind.[6] Ordway Tead, who has contributed extensively to the theory and practice of administration, has suggested the following qualities as desirable for leaders: physical and nervous energy, a sense of purpose and direction, enthusiasm, friendliness and affection, integrity, technical mastery, decisiveness, intelligence in many directions, and teaching skill.[7] In a pamphlet published in 1923, the American Management Association recommended the following qualifications and values in selecting supervisors: personal—30%; mental—45%; moral—15%; and physical—10%.[8] Cleeton and Mason offer as their criterion of executive ability "above average ability in a large number of qualities which can be rated or measured."[9]

It is apparent from this listing of qualities needed by administrators and supervisors that major stress is placed on aspects of personality. In addition, however, a number of other abilities are considered essential. While few would require that the administrator or supervisor should have the highest mental ability within the group that he heads, superior mental ability

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[4] W. V. Bingham. *Administrative Ability.* Washington, D. C.: Society for Personnel Administration, April, 1939.

[5] Johnson O'Connor. *Characteristics of Successful Executives.* Hoboken: Stevens Institute of Technology, 1932.

[6] Erwin H. Schell. *The Technique of Executive Control.* New York: McGraw-Hill, 1930.

[7] Ordway Tead. *The Art of Leadership.* New York: Whittlesey House, 1935.

[8] *Selecting the Supervisory Forces.* New York: American Management Association, 1923.

[9] Glen U. Cleeton and Charles W. Mason. *Executive Ability: Its Discovery and Development.* Yellow Springs: Antioch Press, 1934, p. 12.

is still considered very important.[10] Part of the differences of opinion on this subject may be accounted for by the failure to relate the mental ability required to the group being supervised. The mental ability required of a foreman of laborers is obviously lower than that required of a Construction Superintendent but in relation to the mental ability of his laborers, the foreman should rank high.[11]

The administrator and supervisor must be able to understand organization. Some technically minded persons are constantly frustrated by administrative procedures and regulations when they are promoted to supervisory positions, while others acquire a knowledge of how to get things done which is basic to success, especially in a large organization. Without some evidence it is impossible to state what factors make for success in this particular phase of administrative work, yet one can speculate that this ability is non-intellectual but related to the interests and personality of the person.[12]

Use of Paper-and-Pencil Tests

1. *Interest Inventories.* From the published studies, there is a definite indication that the measurement of interests can contribute substantially to the selection of administrative and supervisory personnel.[13] The major problem is in determining what norms to use and which special interests, in addition to social interest or interest in people, are desirable for the particular group of positions being studied.

In his study of Federal government administrators, Thur-

[10] Cf. Forrest A. Kingsbury. "Psychological Tests for Executives." *Personnel,* IX (1930), 125–126.

[11] Administrative difficulties have occurred frequently because of changes among non-supervisory workers, which resulted in a higher level of mental ability, while the supervisors, relatively unchanged, have in many cases been unable to handle these workers of superior ability. This situation was noticeable in the early 1930's when, because of economic reasons, a large number of able persons accepted employment in low-grade positions.

[12] E. K. Strong, Jr., in an unpublished study prepared in cooperation with the Committee on Public Administration of the Social Science Research Council, found that the administrators in technical fields such as law, engineering, medicine, and accounting do not generally rate their interests in the top bracket in their own profession but have broader interests, mainly in the field of dealing with persons. A part of this study has been published: E. K. Strong, Jr. "Interests of Public Administrators." *Public Personnel Review,* VI (1945), 166–173.

[13] F. H. Achard and Florence H. Clarke. " You *Can* Measure the Probability of Success as a Supervisor." *Personnel,* XXI (1945), 355.

stone found that the Social Scale of the *Allport-Vernon Scale of Values* differentiated among his population better than any other measuring device he used.[14] The Theoretical Scale of the *Scale of Values* also differentiated positively and significantly. The Commercial Interests Scale of *Thurstone's Vocational Interest Schedule* and the Religious Scale of the *Allport-Vernon* also differentiated significantly but negatively.

Achard and Clarke, in their study of 300 supervisors in the Consolidated Edison Company of New York, prepared a special rating scale of the *Strong Vocational Interest Blank for Men (Revised)* and obtained satisfactory results with four different types of supervisors. They state that "it was the best single all-around indicator of supervisory ability."[15]

Strong has prepared an occupational interest scale for public administrators based on his work with the Forest Service and the Committee on Public Administration. The U. S. Civil Service Commission, in its test development work in connection with the administrative intern program, has obtained promising results with the *Kuder Preference Record.*

The early studies in this field and the recent investigations by Strong, Thurstone, and Achard and Clarke indicate that studies of interest, if designed for the particular organizational situation, can contribute significantly to administrative and supervisory selection programs. In using interest inventories, it will probably be found that the appropriate critical scores vary significantly among different types of organizations and at different levels of the organization's hierarchy.

2. *Personality Inventories.* These inventories can be divided into two groups; namely, those of the omnibus type which furnish several measurements for the individual, such as the Bernreuter, and those furnishing a single score, such as Laird's scale on extroversion and introversion. While everyone is agreed that, generally speaking, the personality of the administrator or supervisor is probably the most significant single factor in contributing to successful performance, the information now available would seem to indicate that the

[14] *Op. cit.*, pp. 142–145.
[15] *Op. cit.*, p. 362.

present personality inventories, either for reasons intrinsic or external to them, are only slightly useful for this testing purpose and are substantially less so than the interest inventories. To what extent this result may be produced by the "fudging" of responses is not known.[16] It would seem that a sophisticated group of supervisors and administrators in a competitive situation would be able to "beat" these tests.

Achard and Clarke obtained promising results with the Bernreuter, scaled in accordance with their own methods.[17] Their scale differentiated the good from the poor supervisors in each of the four groups they were studying better than any other test they used except the interest inventory.

Beckman and Levine obtained favorable results with the Allport's A–S test on a group of supervisory employees of the City of Cincinnati.[18] In a monograph on his work with several industrial firms, Hersey reports the use of personality inventories of the omnibus type for supervisory selection. Kingsbury comments in regard to the use of extroversion-introversion tests for this purpose that "since the concepts of introversion and extroversion are so ambiguous, and the various tests intercorrelate so poorly, further analysis and experiment are needed before tests of this type can be accepted with confidence for this purpose."[19] Personality inventories have frequently been used, with some promising results, for comparing leaders with non-leaders in educational institutions. Young and Cooper found, for example, in their study of elementary school children in the 5th through the 8th grades, that the leaders could be characterized as self-sufficient extroverts while neither physical nor mental characteristics or interests differentiated the leaders from the non-leaders.[20]

Basing a conclusion on the studies made, it is evident that

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[16] Jurgensen's use of paired-comparison and rank-order techniques in his experimental form of a personality inventory may contribute to a substantial reduction of this factor. See C. E. Jurgensen, "Report on the Classifications Inventory," *Journal of Applied Prychology*, XXVIII (1944), 445–460.

[17] *Op. cit.*, p. 362.

[18] "Selecting Executives: An Evaluation of Three Tests." *Personnel Journal*, VIII (1930), 415–420.

[19] *Op. cit.*, p. 127.

[20] "Some Factors Associated with Popularity." *Journal of Educational Psychology*, XXXV (1944), 513–535.

the present personality inventories can contribute only slightly to the selection of administrators and supervisors and that this contribution will be further reduced by the fact that candidates may "fudge" in a competitive situation. The factors that these inventories attempt to measure are so important for successful performance that much further work in this area is definitely needed.

3. *Mental Abilities.* The contribution of this type of test to predictions of supervisory success runs the gamut from extreme importance to only slight or no importance. This result is related to the previous discussion where the opinion was expressed that one cannot treat these positions as though they were identical, and the difference in the results obtained is undoubtedly the consequence of differences in job-content plus biases among raters in the organizations being studied.

The results of the Army's officer selection program indicate a fairly high positive correlation between the successful completion of officer candidate schools and general classification test scores. Thurstone in his study of Federal administrators found that the linguistics section of the *American Council on Education Psychological Examination* made a significant and positive differentiation between the better and the poorer administrators. Shuman in his study of 99 foremen obtained a correlation of $+.39 \pm .07$ between the *Otis Q. S. Mental Ability Beta* and performance ratings.[21] Uhrbrock and Richardson, in their thorough study of factory supervisors, found mental ability items useful for differentiating between good and poor supervisors.[22] Achard and Clarke found that the *Otis Self-Administering Test of Mental Ability, Higher Examination,* was of value for each of the four groups of supervisors studied.

The above brief summary indicates that a mental ability test should be included in testing programs for supervisory and administrative positions. The weight given to the test should differ, however, depending upon the type of positions being studied.

[21] "The Value of Aptitude Tests for Factory Workers in the Aircraft Engine and Propeller Industries." *Journal of Applied Psychology,* XXIX (1945), 159.

[22] "Item Analysis: The Basis for Constructing a Test for Forecasting Supervisory Ability." *Personnel Journal,* XII (1933), 141–154.

4. *Special Types of Paper-and-Pencil Tests.* Mechanical aptitude tests have frequently been used, and often with satisfactory results, for the selection of factory supervisors. But the reason for this successful use has not been fully explained. The explanation might lie in the area of the relationship between aptitude and interests, with the successful factory supervisor being a person whose aptitude and interests are directed towards shop and mechanical situations. Whatever the reason may be, however, these tests, especially the *Bennett Mechanical Comprehension Test,* have proved useful.[23]

In preliminary studies of the U. S. Forest Service, the *Interpretation of Data Test* of the Progressive Education Association has given some promising results for the selection of administrators. In various experimental studies of this test on administrative personnel, the candidates have expressed a high opinion of its value.

Uhrbrock and Richardson, in their previously cited study, found that test items on the policies and organization of the company in which the supervisors were employed made a significant contribution to the selection of supervisors. It would be our hypothesis that this type of test has value in selecting administrative or supervisory personnel from among technicians and mechanics because it would identify those persons whose interests lie beyond the technical parts of the positions they are occupying.

A device sometimes used for the selection of supervisors is the multiple-choice or true-false form for measuring the ability of a candidate to get the right answer to questions on supervisory situations. Quentin W. File's test on *How Supervise?* is one form of this type of test. Hersey has also used a similar type of test. It would seem that this type of test measures only the logical factor, and not the emotional factor, in human behavior. In other words, a supervisor may know exactly how to act *in* a given situation but his emotions may lead to a different procedure. This statement is not meant to deny that this type of test has value but that its primary purpose should

[23] See the previously cited studies of Shuman and Achard and Clarke.

probably be to determine the need for training. Its value for selection purposes has not as yet been determined.

Thurstone in his study of Federal administrators obtained significant differences between the good and poor groups on three special types of paper-and-pencil tests, Estimating, Classification, and Gottschaldt figures. The *Estimating Test* requires the candidate, by using logical methods rather than knowledge, to arrive at a statistic. For example, a candidate might be asked the number of telephones in use for non-commercial purposes in the United States for the year 1941. It would be highly improbable that any candidate would know the answer to this question. He would have to rely on estimating to arrive at his answer. In the *Classification Test,* the candidate is asked to sort a number of cards, each containing the name of a prominent individual, into as many groups as he wishes. Thurstone found that the better administrator used fewer categories. The *Gottschaldt Figures Test* is in multiple-choice form and requires the candidate to identify in which one of five large, complicated diagrams there exists a smaller figure. The results obtained by Thurstone justify further study of the value of these tests for selecting administrative and supervisory personnel.

Oral Interviews

At some stage in the selection of supervisory and administrative personnel, an interview is practically always used. But there is no evidence available as to its value. The Army Service Forces is now engaged in a program which indicates, in at least tentative form, that by refining the questions and rating forms used, moderate validity is obtained for this testing device.

The British Army has been using what might be called a group interview in which the candidates are observed in their discussion of a subject selected either by or for them. From observation of this type of interview it would seem that this method, when properly administered, offers valuable information for administrative and supervisory positions.

One of the most common difficulties with the administration

of an oral interview is the need for careful selection and training of raters. Quite often the raters are selected on a chance basis rather than because of their technical competency. Too frequently, also, the training of the raters before the interview has been inadequate in terms of the complexity of the task assigned to them.

Ratings in Training Courses

In those organizations which conduct training programs for administrative and supervisory personnel, objective ratings on performance in these programs should furnish valuable additional information for selection for promotion. The standard conditions under which these training programs can be given would be a definite factor in helping to make these ratings valuable for this purpose. In the promotion examination program adopted recently for shop supervisory positions in Navy field establishments, a rating in the work improvement program is given a weight in determining rank on the eligible register. This examining program is under the direction of the U. S. Civil Service Commission, and includes, in addition to the work improvement program rating, a written test on administration, an oral interview, an evaluation of experience and a performance rating.

Evaluation of Biographical Data

Public personnel agencies use extensively the evaluation of a candidate's background, in terms of experience and training, as a method for rating applicants for administrative and supervisory positions. To the best of our knowledge, there is no information available as to the validity of this test for this type of position. If this testing method is based on much more extensive information than is usually contained on an application blank, it should provide a sound basis for selection if, in addition, improvements can be devised in the method for translating this information into ratings. Intensive study of the validity of this testing method is needed.

Basic to the success of any study of the value of tests is the preparation of a valid criterion. This problem is especially

complex in evaluating administrative and supervisory positions. Practically speaking, in devising tests for one organization, an attempt at agreement within the organization should be made as to the standards to be used in rating. This recognizes that different standards in use by another organization will invalidate the results obtained in the first instance. It can be pointed out that in the most successful studies in this field as much time has been spent in obtaining good ratings as on the testing program itself.

Conclusions

The conclusions we would draw from this summary of trends in testing for administrative and supervisory positions are:

(1) The testing program should include a mental ability test and an interest inventory.

(2) Further study is needed of the value of personality inventories, tests of company policies and organization, and special types of tests such as the *Interpretation of Data* and the Thurstone *Estimating Test.*

(3) The value of ratings in training courses and on biographical data should be explored.

(4) Precise analysis of the jobs being studied is an absolute need in order to identify homogeneous sub-groups.

(5) Differences in the value of particular tests should be expected for different supervisory and administrative jobs.

(6) The evident practical urge to include oral interviews makes necessary further improvements in this testing technique.

ARMY GENERAL CLASSIFICATION TEST SCORES FOR CIVILIAN OCCUPATIONS

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For more than twenty years research workers have been referring to data on intelligence and occupation based on the *Army Alpha* scores and the civilian occupations of enlisted men in World War I.[2] The present study deals with similar material. It reports the *Army General Classification Test* (*GCT*) scores of 18,782 white enlisted men of the Army Air Forces Air Service Command[3] distributed according to their previous civilian occupation. Means and medians and standard deviations are reported for the 74 occupations for which there were samples of sufficient size to be of significance.

The data, more applicable to occupations of today than are the data presented in earlier studies, supplement present knowledge concerning ability levels for occupational groups and are of value in educational and vocational counseling of civilians and especially, at this time, of discharged soldiers.

There has been much discussion as to how well the *Army Alpha* sample represented the general population. At the present time it is impossible to decide that issue with respect to this sample. It is possible that the averages among the professional occupations are too low since conceivably many

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Fryer, Douglas. "Occupational-Intelligence Standards." *School and Society*, XVI (1922), 273–277.
Bingham, Walter V. *Aptitudes and Aptitude Testing*. New York: Harper Bros., 1937, pp. 44–59.

[3] Data were furnished by Lt. Col. R. W. Faubion and Lt. Col. J. L. Webster.

of the best men in the profession would have been officer material. It is more likely that the averages among the lowest scoring occupations are too high since for a while the Army Air Forces were receiving a smaller percentage of enlisted men with low scores on the *GCT* than were the Army Ground and the Army Service Forces.

Scores were obtained from Informational Rosters made up from Soldier's Qualification Cards and other sources. Only those cases were included where the roster clearly indicated the previous civilian occupation of the soldier by job title. The job titles in the following tables are those given and described in Army Regulation 615–26, Index and Specifications for Civilian and Military Occupational Specialists, or in the U. S. Employment Service Dictionary of Occupational Titles. In a few instances, however, a general job title has been used in this study instead of the more specific breakdowns of the job described in A.R. 615–26, i.e., Engineer includes mechanical, civil and mining engineers. These general job titles are Engineer, Laboratory Assistant, Inspector, Musician, Foreman, Electrician, Assembler and Welder, Manager, and Miscellaneous. Miscellaneous is a general title which includes managers of various business establishments, i.e., moving picture theaters, bowling alleys, etc., but excludes managers of retail stores. Manager, Retail Store includes managers of both chain and independent retail stores. Mechanic includes all kinds of mechanics except air-plane and automobile mechanics.

The desired maximum size of sample for a single occupation was 500 cases, and when that maximum was reached further tabulation of the occupation was discontinued except in a few instances where the range of scores was great. For the majority of the occupations 500 cases were not available. It was originally planned to omit all occupations with less than 100 cases; some have been included, however, as they involve several professional groups in which there is considerable interest.

In order to provide a rough check on the reliability of the size of the sample, the scores for each occupation were tabulated in two distributions, A and B, of approximately the same

TABLE 1

Mean and Median GCT Standard Scores, Standard Deviations and Range of Scores of 18,782 AAF White Enlisted Men by Civilian Occupation

Occupation	N	M	Median	Standard deviation	Range
Accountant	172	128.1	128.1	11.7	94–157
Lawyer	94	127.6	126.8	10.9	96–157
Engineer	39	126.6	125.8	11.7	100–151
Public Relations Man	42	126.0	125.5	11.4	100–149
Auditor	62	125.9	125.5	11.2	98–151
Chemist	21	124.8	124.5	13.8	102–153
Reporter	45	124.5	125.7	11.7	100–157
Chief Clerk	165	124.2	124.5	11.7	88–153
Teacher	256	122.8	123.7	12.8	76–155
Draftsman	153	122.0	121.7	12.8	74–155
Stenographer	147	121.0	121.4	12.5	66–151
Pharmacist	58	120.5	124.0	15.2	76–149
Tabulating Machine Operator	140	120.1	119.8	13.3	80–151
Bookkeeper	272	120.0	119.7	13.1	70–157
Manager, Sales	42	119.0	120.7	11.5	90–137
Purchasing Agent	98	118.7	119.2	12.9	82–153
Manager, Production	34	118.1	117.0	16.0	82–153
Photographer	95	117.6	119.8	13.9	66–147
Clerk, General	496	117.5	117.9	13.0	68–155
Clerk-Typist	468	116.8	117.3	12.0	80–147
Manager, Miscellaneous	235	116.0	117.5	14.8	60–151
Installer-Repairman, Tel & Tel	96	115.8	116.8	13.1	76–149
Cashier	111	115.8	116.8	11.9	80–145
Instrument Repairman	47	115.5	115.8	11.9	82–141
Radio Repairman	267	115.3	116.5	14.5	56–151
Printer, Job Pressman, Lithographic Pressman	132	115.1	116.7	14.3	60–149
Salesman	494	115.1	116.2	15.7	60–153
Artist	48	114.9	115.4	11.2	82–139
Manager, Retail Store	420	114.0	116.2	15.7	52–151
Laboratory Assistant	128	113.4	114.0	14.6	76–147
Tool Maker	60	112.5	111.6	12.5	76–143
Inspector	358	112.3	113.1	15.7	54–147
Stock Clerk	490	111.8	113.0	16.3	54–151
Receiving and Shipping Clerk	486	111.3	113.4	16.4	58–155
Musician	157	110.9	112.8	15.9	56–147
Machinist	456	110.1	110.8	16.1	38–153
Foreman	298	109.8	111.4	16.7	60–151
Watchmaker	56	109.8	113.0	14.7	68–147
Airplane Mechanic	235	109.3	110.5	14.9	66–147
Sales Clerk	492	109.2	110.4	16.3	42–149
Electrician	289	109.0	110.6	15.2	64–149
Lathe Operator	172	108.5	109.4	15.5	64–147
Receiving & Shipping Checker	281	107.6	108.9	15.8	52–151
Sheet Metal Worker	498	107.5	108.1	15.3	62–153
Lineman, Power and Tel & Tel	77	107.1	108.8	15.5	70–133

TABLE 1 (*Continued*)

Occupation	N	M	Median	Standard deviation	Range
Assembler	498	106.3	106.6	14.6	48–145
Mechanic	421	106.3	108.3	16.0	60–155
Machine Operator	486	104.8	105.7	17.1	42–151
Auto Serviceman	539	104.2	105.9	16.7	30–141
Riveter	239	104.1	105.3	15.1	50–141
Cabinetmaker	48	103.5	104.7	15.9	66–127
Upholsterer	59	103.3	105.8	14.5	68–131
Butcher	259	102.9	104.8	17.1	42–147
Plumber	128	102.7	104.8	16.0	56–139
Bartender	98	102.2	105.0	16.6	56–137
Carpenter, Construction	451	102.1	104.1	19.5	42–147
Pipe Fitter	72	101.9	105.2	18.0	56–139
Welder	493	101.8	103.6	16.1	48–147
Auto Mechanic	466	101.3	101.8	17.0	46–151
Molder	79	101.1	105.5	20.2	48–137
Chauffeur	194	100.8	103.0	18.4	46–143
Tractor Driver	354	99.5	101.6	19.1	42–147
Painter, General	440	98.3	100.1	18.7	38–147
Crane Hoist Operator	99	97.9	99.1	16.6	58–147
Cook and Baker	436	97.2	99.5	20.8	20–147
Weaver	56	97.0	97.3	17.7	50–135
Truck Driver	817	96.2	97.8	19.7	16–149
Laborer	856	95.8	97.7	20.1	26–145
Barber	103	95.3	98.1	20.5	42–141
Lumberjack	59	94.7	96.5	19.8	46–137
Farmer	700	92.7	93.4	21.8	24–147
Farmhand	817	91.4	94.0	20.7	24–141
Miner	156	90.6	92.0	20.1	42–139
Teamster	77	87.7	89.0	19.6	46–145

size. The difference between the means of A and B for each of the 48 occupations with 100 or more cases ranged from 0.1 to 5.1 and averaged 1.7. (The median difference was 1.3.) For the 26 occupations with less than 100 cases, the difference between the means of groups A and B ranged from 0.4 to 11.7 and averaged 3.7. (The median difference was 3.0.)

Table 1 gives the mean, median, standard deviation and range for 74 occupations. The means and medians were calculated from distributions grouping scores by intervals of two. The standard deviations were calculated from distributions grouped to provide from 12 to 18 class intervals.

Table 2 gives the percentage distribution of each occupation. It shows, as have other similar studies, the great overlapping of scores between occupations. Even Teamster, the

TABLE 2

Percentage Distribution of GCT Standard Scores by Civilian Occupation of 18,782 AAF White Enlisted Men

	Accountant	Lawyer	Engineer	Pub. Rel. Man	Auditor	Chemist	Reporter	Chief Clerk	Teacher	Draftsman	Stenographer	Pharmacist	Tab. Mach. Oper.	Bookkeeper	Sales Mgr.	Purch. Agent	Prod. Mgr.	Photographer	Clerk, Genl	Clerk-Typist	Mgr., Misc.	Inst.-Repair, Tel & Tel	Cashier	Instrument Repairman	Radio Repair	Printer	Salesman	Artist	Mgr. Retail Store	Lab. Asst.	Tool Maker	Inspector	Stock Clerk	R/S Clerk	Musician	Machinist	Foreman	
150–159	3	2	8		2	9	4	1	1	2	1		1	2			3	3		1																•	•	150–159
140–149	13	14	5	12	8	10	2	8	7	8	4	5	7	3			3	3	2	3	4	3	1	2	2	4	2			4	3	2	1	1	2	2	140–149
130–139	25	17	15	17	24	5	27	18	16	15	17	17	13	14	17	16	20	10	12	9	11	7	7	11	8	8	13	6	13	8	2	12	8	9	6	5	130–139
120–129	31	47	46	36	36	38	29	35	37	31	34	41	29	29	38	28	18	37	28	30	29	33	32	21	31	27	24	23	23	20	23	17	20	18	25	21	22	120–129
110–119	22	15	18	26	24	24	29	30	26	24	28	21	26	32	19	30	27	24	31	31	24	26	30	32	29	27	28	50	28	30	29	26	28	31	27	24	25	110–119
100–109	4	4	8	9	5	14	9	6	8	18	11	5	18	13	19	14	20	18	16	19	20	18	20	23	18	19	19	9	17	20	30	23	19	19	18	25	23	100–109
90– 99	2	1			1			1	3	1	4	2	4	6	7	5	3	4	7	6	7	9	6	9	7	10	7	8	8	13	8	11	14	10	13	12	10	90– 99
80– 89								1	2	0	1	7	2	1		3	6		2	2	2	4	3	4	2	3	4	3	6	4	3	6	5	7	6	6	8	80– 89
70– 79								•	1	0	2	•							1	1	•				1	0	3	2	1	2	2	2	2	3	2	4	3	70– 79
60– 69									•	1	•								1	•		1			1	1	1		1	2	1	1	2	1	1	1	2	60– 69
50– 59																																	•	•	1	0		50– 59
40– 49																																				0	•	40– 49
30– 39																																						30– 39
20– 29																																						20– 29
10– 19																																						10– 19

• Fewer than 0.5% cases.

TABLE 2 (*Continued*)

	Watchmaker	Airpl. Mech.	Sales Clerk	Electrician	Lathe Operator	R/S Checker	Sheet Metal Worker	Lineman	Assembler	Mechanic	Machine Oper.	Auto Service.	Riveter	Cabinetmaker	Upholsterer	Butcher	Plumber	Bartender	Carpenter	Pipe Fitter	Welder	Auto Mechanic	Molder	Chauffeur	Tractor Driver	Painter	Crane Hoist Operator	Cook & Baker	Weaver	Truck Driver	Laborer	Barber	Lumberjack	Farmer	Farmhand	Miner	Teamster	
150–159						•	•															•															150–159
140–149	2	1	2	2	2	2	2		1	4	1	•	•			•					•	1	•	1	1	1	1		1	1	1		1	•		1	140–149
130–139	3	5	6	5	6	5	4	4	3	13	4	4	4		3	4	2	3	5	6	1	3	1	4	3	2	0	2	2	2	0	2	2	1	1	0	130–139
120–129	11	18	15	15	12	16	15	25	12	25	13	12	9	17	5	10	13	9	11	10	10	8	14	7	11	8	5	11	7	8	7	11	5	8	5	6	4	120–129
110–119	37	27	27	30	27	23	23	17	24	26	22	24	21	21	29	23	20	17	18	18	23	18	24	22	17	17	19	15	13	15	15	18	13	12	13	11	7	110–119
100–109	20	25	24	22	30	22	26	18	30	14	21	22	29	27	27	22	27	33	24	29	24	25	22	21	22	23	21	20	23	20	21	14	22	18	19	15	12	100–109
90– 99	18	13	13	15	9	20	18	22	18	10	21	16	21	15	15	17	17	15	15	11	18	21	16	18	23	15	29	18	29	18	18	23	15	18	19	23	9	90– 99
80– 89	4	6	7	6	10	9	8	9	7	5	9	13	12	10	10	14	12	12	13	10	12	13	4	14	12	16	16	16	12	15	14	12	10	13	14	14	18	80– 89
70– 79	3	4	4	4	2	2	3	5	4	2	6	7	4	8	9	7	5	8	6	11	9	7	8	9	10	7	8	11	5	11	10	17	12	15	12	17	12	70– 79
60– 69	2	1	2	1	2	1	1		1		2	2	•	2	2	2	3	2	5	4	2	3	5	5	4	5	6	5	1	5	7	7	5	7	10	11	11	15	60– 69
50– 59			0			•			0		1	•	•			•	1	1	1	1	1	•	1	1	0	2	2	1	2	4	2	3	1	5	3	4	4	4	50– 59
40– 49			•						•		•	0	•			1		1				•	1	1	1	1	•		1	1	2	3	2	3	2	2	4	40– 49
30– 39												•																			•	0	1					30– 39
20– 29																												1		•	•			•				20– 29
10– 19																														•								10– 19

* Fewer than 0.5% cases.

TABLE 3

Critical Ratios between the Means of Pairs of 74 Civilian Occupations (N = 18,782 White Enlisted Men, AAF)

	Accountant	Lawyer	Engineer	Pub. Rel. Man	Auditor	Chemist	Reporter	Chief Clerk	Teacher	Draftsman	Stenographer	Pharmacist	Tab. Mach. Oper.	Bookkeeper	Sales Mgr.	Purch. Agent	Prod. Mgr.	Photographer	Clerk, Gen'l
Accountant		.3	.7	1.1	1.3	1.1	1.8	*											
Lawyer	.3		.5	.8	.9	.9	1.5	2.3											
Engineer	.7	.5		.2	.3	.5	.8	1.2	1.9	2.1	2.6	2.2			2.9		2.6		
Pub. Rel. Man	1.1	.8	.2		0	.3	.6	.9	1.7	2.0	2.5	2.1	2.8		2.8		2.4		
Auditor	1.3	.9	.3	0		.3	.6	1.0	1.9	2.2	2.8	2.2					2.5		
Chemist	1.1	.9	.5	.3	.3		.1	.2	.6	.9	1.2	1.2	1.5	1.5	1.7	1.9	1.6	2.2	2.4
Reporter	1.8	1.5	.8	.6	.6	.1		.2	.9	1.2	1.7	1.5	2.1	2.3	2.2	2.7	2.0		
Chief Clk.	*	2.3	1.2	.9	1.0	.2	.2		1.2	1.6	2.3	1.7	2.8		2.6		2.1		
Teacher			1.9	1.7	1.9	.6	.9	1.2		.6	1.4	1.1	2.0	2.5	2.0	2.7	1.6		
Draftsman			2.1	2.0	2.2	.9	1.2	1.6	.6		.7	.7	1.2	1.5	1.5	2.0	1.3	2.5	
Steno.			2.6	2.5	2.8	1.2	1.7	2.3	1.4	.7		.2	.6	.8	1.0	1.4	1.0	1.9	
Pharmacst			2.2	2.1	2.2	1.2	1.5	1.7	1.1	.7	.2		.2	.2	.6	.8	.7	1.2	1.4
Tab. Mach. Op.				2.8		1.5	2.1	2.8	2.0	1.2	.6	.2		.1	.5	.8	.7	1.4	2.0
Bookkeeper						1.5	2.3		2.5	1.5	.8	.2	.1		.5	.8	.7	1.5	2.5
Sales Mgr.			2.9	2.8		1.7	2.2	2.6	2.0	1.5	1.0	.6	.5	.5		.1	.3	.6	.8
Purch. Agnt.						1.9	2.7		2.7	2.0	1.4	.8	.8	.8	.1		.2	.6	.8
Prod. Mgr.			2.6	2.4	2.5	1.6	2.0	2.1	1.6	1.3	1.0	.7	.7	.7	.3	.2		.2	.2
Photogrphr.						2.2				2.5	1.9	1.2	1.4	1.5	.6	.6	.2		.1
Clk., Gen'l						2.4						1.4	2.0	2.5	.8	.8	.2	.1	
Clk.-Typist						2.6						1.8	2.6		1.2	1.3	.5	.5	.9
Mgr. Misc.						2.8						2.0	2.8		1.5	1.7	.7	.9	1.3
In.-Rep., T & T						2.7						2.0	2.5	2.7	1.4	1.6	.8	.9	1.2
Cashier						2.8						2.1	2.7		1.5	1.7	.8	1.0	1.3
Inst. Rep.						2.7					2.7	1.9	2.2	2.4	1.4	1.5	.8	.9	1.1
Radio Rep.												2.4			1.9	2.2	1.0	1.4	2.1
Printer												2.3			1.8	2.0	1.0	1.3	1.7
Saleman												2.5			2.0	2.4	1.1	1.6	2.6
Artist						2.9						2.2	2.6	2.8	1.7	1.8	1.0	1.3	1.5
Mgr. Ret. Str.															2.6		1.4	2.2	
Lab. Asst.															2.6	2.9	1.6	2.2	2.9
Tool Maker															2.7		1.8	2.4	2.9
Inspector																	2.0		
Stock Clerk																	2.2		
R/S Clerk																	2.4		
Musician																	2.4		
Machinist																	2.8		
Foreman																	2.9		
Watchmaker																	2.5		

* Where the critical ratio is 3 or more, no entry has been made in the table.

TABLE 3 (*Continued*)

Critical Ratios between the Means of 74 Civilian Occupations (N = 18,782 White Enlisted Men, AAF)

	Clerk-Typist	Mgr., Misc.	Inst.-Rep., Tel & Tel	Cashier	Inst. Repairman	Radio Repairmen	Printer	Salesman	Artist	Mgr., Ret. Store	Lab. Asst.	Tool Maker	Inspector	Stock Clerk	R/S Clerk	Musician	Machinist	Foreman
Chemist	2.6	2.8	2.7	2.8	2.7	*			2.9									
Reporter	*																	
Chief Clk.																		
Teacher																		
Draftsman																		
Steno.					2.7													
Pharmacist	1.8	2.0	2.0	2.1	1.9	2.4	2.3	2.5	2.2									
Tab. Mach. Op.	2.6	2.8	2.5	2.7	2.2				2.6									
Bookkeeper			2.7		2.4				2.8									
Sales Mgr.	1.2	1.5	1.4	1.5	1.4	1.9	1.8	2.0	1.7	2.6	2.6	2.7						
Purch. Agnt.	1.3	1.7	1.6	1.7	1.5	2.2	2.0	2.4	1.8		2.9							
Prod. Mgr.	.5	.7	.8	.8	.8	1.0	1.0	1.1	1.0	1.4	1.6	1.8	2.0	2.2	2.4	2.4	2.8	2.9
Photogrphr.	.5	.9	.9	1.0	.9	1.4	1.3	1.6	1.3	2.2	2.2	2.4						
Clk., Gen'l	.9	1.3	1.2	1.3	1.1	2.1	1.7	2.6	1.5		2.9	2.9						
Clk.-Typist		.7	.7	.8	.7	1.4	1.3	1.9	1.1	2.9	2.4	2.5						
Mgr., Misc.	.7		.1	.1	.3	.5	.6	.8	.6	1.6	1.6	1.9	2.9					
In.-Rep., T & T	.7	.1		0	.1	.3	.4	.5	.4	1.2	1.3	1.6	2.2	2.6	2.9	2.7		
Cashier	.8	.1	0		.1	.3	.4	.5	.5	1.3	1.4	1.7	2.5			2.9		
Inst. Rep.	.7	.3	.1	.1		.1	.2	.2	.3	.8	1.0	1.3	1.7	2.0	2.2	2.1	2.9	2.9
Radio Rep.	1.4	.5	.3	.3	.1		.1	.2	.2	1.1	1.2	1.5	2.5			2.8		
Printer	1.3	.6	.4	.4	.2	.1		0	.1	.8	.9	1.3	1.9	2.3	2.6	2.4		
Salesman	1.9	.8	.5	.5	.2	.2	0		.1	1.1	1.2	1.5	2.6			2.9		
Artist	1.1	.6	.4	.5	.3	.2	.1	.1		.5	.7	1.1	1.4	1.7	2.0	1.9	2.7	2.7
Mgr. Ret. Store	2.9	1.6	1.2	1.3	.8	1.1	.8	1.1	.5		.4	.8	1.5	2.1	2.5	2.1		
Lab. Asst.	2.4	1.6	1.3	1.4	1.0	1.2	.9	1.2	.7	.4		.4	.7	1.1	1.4	1.4	2.2	2.2
Tool Maker	2.5	1.9	1.6	1.7	1.3	1.5	1.3	1.5	1.1	.8	.4		.1	.4	.7	.8	1.3	1.4
Inspector		2.9	2.2	2.5	1.7	2.5	1.9	2.6	1.4	1.5	.7	.1		.5	.9	.9	2.0	2.0
Stock Clk.			2.6		2.0		2.3		1.7	2.1	1.1	.4	.5		.5	.6	1.6	1.6
R/S Clerk			2.9		2.2		2.6		2.0	2.5	1.4	.7	.9	.5		.3	1.1	1.2
Musician			2.7	2.9	2.1	2.8	2.4	2.9	1.9	2.1	1.4	.8	.9	.6	.3		.5	.7
Machinist					2.9				2.7		2.2	1.3	2.0	1.6	1.1	.5		.2
Foreman					2.9				2.7		2.2	1.4	2.0	1.6	1.2	.7	.2	
Watchmaker		2.8	2.5	2.6	2.2	2.6	2.3	2.5	2.0	2.0	1.5	1.1	1.2	1.0	.7	.5	.1	0
Airpl. Mech.											2.5	1.7	2.3	2.0	1.6	1.0	.7	.4
Sales Clk.											2.8	1.9	2.8	2.5	2.0	1.2	.9	.5
Electric'n											2.8	1.9	2.7	2.4	2.0	1.2	1.0	.6
Lathe Oper.											2.8	2.0	2.6	2.4	2.0	1.4	1.1	.8
R/S Checkr.												2.6				2.1	2.1	1.6
Sheet Mtl. Wkr.												2.9				2.4	2.5	1.9
Lineman											2.9	2.3	2.7	2.5	2.2	1.8	1.6	1.3
Assembler																		
Mechanic																		2.8
Mach. Oper.																		
Auto Serv.																		
Riveter																		
Cabinetmkr.																2.8	2.7	2.5

* Where the critical ratio is 3 or more, no entry has been made in the table.

TABLE 3 (*Continued*)

Critical Ratios between the Means of 74 Civilian Occupations (N = 18,782 White Enlisted Men, AAF)

	Watchmaker	Airpl. Mech.	Sales Clerk	Electrician	Lathe Operator	R/S Checker	Sht. Met. Worker	Lineman	Assembler	Mechanic	Machine Oper.	Auto Service.	Riveter	Cabinetmaker	Upholsterer	Butcher	Plumber	Bartender
	**																	
Lab. Asst.	1.5	2.5	2.8	2.8	2.8	*		2.9										
Tool Maker	1.1	1.7	1.9	1.9	2.0	2.6	2.9	2.3										
Inspector	1.2	2.3	2.8	2.7	2.6			2.7										
Stock Clk.	1.0	2.0	2.5	2.4	2.4			2.5										
R/S Clerk	.7	1.6	2.0	2.0	2.0			2.2										
Musician	.5	1.0	1.2	1.2	1.4	2.1	2.4	1.8						2.8				
Machinist	.1	.7	.9	1.0	1.1	2.1	2.5	1.6						2.7				
Foreman	0	.4	.5	.6	.8	1.6	1.9	1.3		2.8				2.5				
Watchmaker		.2	.3	.4	.6	1.0	1.1	1.0	1.7	1.7	2.4	2.7	2.6	2.1	2.4		2.9	2.9
Airpl. Mech.	.2		.1	.2	.5	1.3	1.5	1.1	2.6	2.4				2.3	2.8			
Sales Clk.	.3	.1		.2	.5	1.3	1.7	1.1		2.7				2.4	2.9			
Electric'n	.4	.2	.2		.3	1.1	1.3	1.0	2.4	2.3				2.2	2.7			
Lathe Oper.	.6	.5	.5	.3		.6	.7	.7	1.6	1.5	2.6		2.9	1.9	2.3			
R/S Checker	1.0	1.3	1.3	1.1	.6		.1	.3	1.1	1.1	2.3	2.9	2.6	1.7	2.0		2.9	2.8
Sheet Mtl. Wkr.	1.1	1.5	1.7	1.3	.7	.1		.2	1.3	1.2	2.6		2.9	1.7	2.1			2.9
Lineman	1.0	1.1	1.1	1.0	.7	.3	.2		.4	.4	1.2	1.5	1.5	1.2	1.5	2.0	1.9	2.0
Assembler	1.7	2.6		2.4	1.6	1.1	1.3	.4		0	1.5	2.2	1.9	1.2	1.5	2.7	2.3	2.3
Mechanic	1.7	2.4	2.7	2.3	1.5	1.1	1.2	.4	0		1.4	2.0	1.8	1.2	1.5	2.6	2.2	2.2
Mach. Oper.	2.4				2.6	2.3	2.6	1.2	1.5	1.4		.6	.6	.5	.7	1.4	1.3	1.4
Auto Serv.	2.7					2.9		1.5	2.2	2.0	.6		.1	.3	.4	1.0	1.0	1.1
Riveter	2.6				2.9	2.6	2.9	1.5	1.9	1.8	.6	.1		.2	.4	.8	.8	1.0
Cabinetmkr	2.1	2.3	2.4	2.2	1.9	1.7	1.7	1.2	1.2	1.2	.5	.3	.2		.1	.2	.3	.5
Upholsterer	2.4	2.8	2.9	2.7	2.3	2.0	2.1	1.5	1.5	1.5	.7	.4	.4	.1		.2	.3	.4
Butcher	*							2.0	2.7	2.6	1.4	1.0	.8	.2	.2		.1	.4
Plumber	2.9					2.9		1.9	2.3	2.2	1.3	1.0	.8	.3	.3	.1		.2
Bartender	2.9					2.8	2.9	2.0	2.3	2.2	1.4	1.1	1.0	.5	.4	.4	.2	
Carpenter								2.5			2.3	1.8	1.5	.6	.6	.6	.4	.1
Pipe Fitter	2.7				2.7	2.5	2.5	1.9	2.0	1.9	1.3	1.0	.9	.5	.5	.4	.3	.1
Welder								2.8			2.8	2.4	1.9	.7	.7	.9	.6	.2
Auto Mech.												2.7	2.2	.9	1.0	1.2	.9	.5
Molder					2.9	2.6	2.7	2.1	2.2	2.2	1.5	1.3	1.2	.7	.7	.7	.6	.4
Chauffeur								2.9			2.6	2.3	2.0	1.0	1.1	1.2	1.0	.7
Tractr Drvr.														1.6	1.8	2.3	1.8	1.4
Painter														2.1	2.4		2.6	2.1
Crane Hoist Op.														2.0	2.1	2.5	2.2	1.8
Cook and Baker														2.5	2.9			2.6
Weaver												2.9	2.8	2.0	2.1	2.3	2.1	1.8
Truck Drvr.																		
Laborer																		
Barber														2.7	2.9			2.6
Lumberjack														2.6	2.7	2.9	2.7	2.4

* Where the critical ratio is 3 or more, no entry has been made in the table.

** The following are additional critical ratios for Watchmaker: Watchmaker and Prod. Mgr., 2.5; and Mgr., Misc., 2.8; Tel & Tel Installer-Repairman, 2.5; Cashier, 2.6; Instrument Repair., 2.2; Radio Repair., 2.6; Printer, 2.3; Salesman, 2.5; Artist, 2.0; Mgr. Retail Store, 2.0.

TABLE 3 (*Continued*)

Critical Ratios between the Means of 74 Civilian Occupations (N = 18,782 White Enlisted Men, AAF)

	Carpenter	Pipe Fitter	Welder	Auto Mechanic	Molder	Chauffeur	Tractor Driver	Painter	Crane Hoist Operator	Cook & Baker	Weaver	Truck Driver	Laborer	Barber	Lumberjack	Farmer	Farmhand	Miner	Teamster
Watchmkr	*	2.7																	
Airpl. Mech.																			
Sales Clk.																			
Electrtn.																			
Lathe Op.		2.7			2.9														
R/S Checker		2.5			2.6														
S. Mtl. Wkr.		2.5			2.7														
Lineman	2.5	1.9	2.8		2.1	2.9													
Assmbler		2.0			2.2														
Mechanic		1.9			2.2														
Mach. Oper.	2.3	1.3	2.8		1.5	2.6													
Auto Serv.	1.8	1.0	2.4	2.7	1.3	2.3					2.9								
Riveter	1.5	.9	1.9	2.2	1.2	2.0					2.8								
Cabinetmkr.	.6	.5	.7	.9	.7	1.0	1.6	2.1	2.0	2.5	2.0			2.7	2.6				
Upholsterer	.6	.5	.7	1.0	.7	1.1	1.8	2.4	2.1	2.9	2.1			2.9	2.7				
Butcher	.6	.4	.9	1.2	.7	1.2	2.3		2.5		2.3				2.9				
Plumber	.4	.3	.6	.9	.6	1.0	1.8	2.6	2.2		2.1				2.7				
Bartender	.1	.1	.2	.5	.4	.7	1.4	2.1	1.8	2.6	1.8			2.6	2.4				
Carpenter		.1	.3	.7	.4	.8	1.9		2.2		2.0				2.7				
Pipefitter	.1		0	.3	.3	.4	1.0	1.6	1.5	2.0	1.5	2.6	2.7	2.3	2.2				
Welder	.3	0		.5	.3	.7	1.8		2.1		1.9				2.6				
Auto Mech.	.7	.3	.5		.1	.3	1.4	2.5	1.8		1.7			2.8	2.4				
Molder	.4	.3	.3	.1		.1	.6	1.1	1.1	1.6	1.3	2.1	2.2	1.9	1.9				
Chauffeur	.8	.4	.7	.3	.1		.8	1.6	1.4	2.2	1.4			2.3	2.1				
Tract Drvr.	1.9	1.0	1.8	1.4	.6	.8		.9	.8	1.6	1.0	2.7		1.9	1.7				
Painter		1.6		2.5	1.1	1.6	.9		.2	.8	.5	1.9	2.2	1.4	1.3				
Crane Hst. Op.	2.2	1.5	2.1	1.8	1.1	1.4	.8	.2		.4	.3	.9	1.2	1.0	1.0	2.8			
Cook-Baker		2.0			1.6	2.2	1.6	.8	.4		.1	.8	1.2	.8	.9				
Weaver	2.0	1.5	1.9	1.7	1.3	1.4	1.0	.5	.3	.1		.3	.5	.5	.7	1.7	2.2	2.2	2.9
Truck Drvr.		2.6			2.1		2.7	1.9	.9	.8	.3		.4	.4	.6				
Laborer		2.7			2.2			2.2	1.2	1.2	.5	.4		.2	.4	2.9			
Barber		2.3		2.8	1.9	2.3	1.9	1.4	1.0	.8	.5	.4	.2		.2	1.2	1.8	1.8	2.5
Lumberjack	2.7	2.2	2.6	2.4	1.9	2.1	1.7	1.3	1.0	.9	.7	.6	.4	.2		.7	1.2	1.3	2.1
Farmer									2.8		1.7		2.9	1.2	.7		1.2	1.2	2.1
Farmhand											2.2			1.8	1.2	1.2		.5	1.6
Miner											2.2			1.8	1.3	1.2	.5		1.1
Teamster											2.9			2.5	2.1	2.1	1.6	1.1	

* Where the critical ratio is 3 or more, no entry has been made in the table.

occupation with the lowest mean, has 2% of its cases scoring as high as the mean of Accountant, the occupation with the highest mean. On the other hand the top seven occupations have no cases as low as the mean score for Teamster. Evidently a certain minimum of intelligence is required for any one of many occupations and a man must have that much intelligence in order to function in that occupation, but a man may have high intelligence and be found in a lowly occupation because he lacks other qualifications than intelligence.

Table 3 gives the critical ratios between the means of each occupation compared with every other occupation. Where the critical ratio was 3 or more no entry has been made in the table. The table shows, as does Table 2, both the overlapping and differentiation between occupations. In general, the mean of an occupation is not significant within a range of approximately ± 10 occupations where the occupations have been arranged in descending order of means. This range would have been less if all of the occupations had had at least 100 cases. It is all the more interesting, consequently, that Chemist with 21 cases, Engineer with 39, Public Relations Man with 42 and Reporter with 45 cases have means significantly higher than those of at least 49 other occupations.

As is always found in studies of this kind, the professional and clerical administrative groups of occupations show the highest average scores. Those occupations with average scores of 120 or more are, in the order of their superiority: Accountant, Lawyer, Engineer, Public Relations Man, Auditor, Chemist, Reporter, Chief Clerk, Teacher, Draftsman, Stenographer, Pharmacist, Tabulating Machine Operator and Bookkeeper.

Since the *GCT* is a measure of ability to manipulate words, numbers and space relations, it is to be expected that those occupations with the lowest averages on the test are likewise the occupations least concerned with words, numbers or space relations. Lowest scoring occupations from low to high are Teamster, Miner, Farmhand, Farmer, Lumberjack, Barber, Laborer and Truck Driver.

MECHANICAL ABILITY, ITS NATURE AND MEASUREMENT. I. AN ANALYSIS OF THE VARIABLES EMPLOYED IN THE PRELIMINARY MINNESOTA EXPERIMENT

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A Review of the Minnesota Program

THE present study comprises a brief review of the preliminary Minnesota experiment and a factorial analysis of the variables. The purpose of this paper is to apply modern analytical techniques to the interesting problem of the nature of mechanical ability which was begun some two decades ago by the authors of the Minnesota experiment (5).

Although the Minnesota research had as its primary aim the discovery and measurement of mechanical ability, the term "mechanical ability" has never been rigidly and unambiguously defined. Since what is meant by mechanical ability has never been perfectly general, procedures for assaying the degree of mechanical ability are held to be appropriate by various investigators to varying degrees. In general, however, mechanical ability has been an expression for whatever ability or abilities are required for creditable work with tools and machinery, i.e., mechanical work. The exact nature of mechanical ability was not specified by the authors of the Minnesota study; it was instead likened by them to intelligence. It was considered to be a general function, probably comprising constituent parts, the precise identity and importance of each varying from authority to authority.

The question of the organization and composition of mechanical ability is, of course, critical for economical testing procedures. Since the publication of the Minnesota studies, new analytical techniques have been devised and employed.

It is possible that by combining the contributions of various investigators a tentative answer to the question of the organization of mechanical ability may be offered. The answer must be regarded as tentative not only because our researches to date are by no means exhaustive but also for a more positive reason. The performances which investigators have found desirable to scrutinize and to measure are determined by the requirements and the characteristics of our culture. As mechanical and other practical operations change perhaps old requirements become less important and new ones rise to importance. Different technical devices will be developed and the precise composition of that loosely defined group of abilities referred to as "mechanical" must be expected to change.

Of the several patterns of speculation concerning the composition of abilities, the theory of unique traits has been most provocative. This theory has been linked with such names as Hull, Kelley, Thurstone, Thorndike, and Woodrow. It, in general, provides two assumptions: (1) that all variability in human behavior may be expressed as a function of a limited number of independent, elemental abilities and (2) that these abilities may be discovered and suitable tests designed. This theory had been influencing psychometric research some time prior to the publication of the *Minnesota Mechanical Ability Tests*. Its full effect was not felt, however, until the invention of a practicable factor analysis by Thurstone. Before the development of effective factorial methods, a variety of expedients were employed by those who desired to make explorations in the area of human ability.

In the preliminary experiment, the literature was carefully surveyed for the purpose of selecting tests which were known to possess encouraging validity and reliability. The practical problems involved in their administration were considered. Particular effort was made in the selection to avoid including more than one test which appeared to measure the same aspect of mechanical ability. Twenty-six tests were selected, reorganized, and in some cases greatly changed with respect to instructions, conditions of administration, or length. Although the authors claimed that test individuality was emphasized in

the selection, it was possible for them to make a provisional classification of the tests under seven general headings. The headings indicated the nature of the operation which the tests appear to be measuring (5, 43–44).

I. Standard group intelligence tests
   1. Army Alpha, Form 6 (group paper)
   2. Otis Self-Administering Tests of Mental Ability, Higher Examination: Form A (group paper)

II. Simple motor tests
   1. Tapping Test A (group paper)
   2. Tapping Test B (group paper)
   3. Tapping Test C (individual apparatus)
   4. Steadiness of Motor Control (individual apparatus)
   5. Accuracy of Movement or Tracing Paper (group paper)
   6. Accuracy of Movement or Tracing Board (individual apparatus)
   7. Aiming (individual paper)
   8. Speed of Movement (group paper)

III. Balancing tests
   1. Body Balancing (individual apparatus)
   2. Stick Balancing (individual apparatus)

IV. Complex eye-hand coordination tests
   1. Link's Machine Operator's (individual apparatus)
   2. Card Sorting (individual apparatus)
   3. Card Assembly (individual apparatus)
   4. Packing Blocks (individual apparatus)

V. Assembly tests involving manipulation and responses to spatial relations
   1. Stenquist Assembly (group apparatus)
   2. Paper Form Board (group paper)
   3. Link's Spatial Relations (individual apparatus)
   4. Cube Construction (group apparatus)

VI. Tests of mechanical knowledge
   1. Stenquist Picture Tests I and II (group paper)

VII. Miscellaneous tests
1. Slow Movement or Motor Inhibition (individual paper)
2. Digit-Symbol Substitution (group paper)
3. Letter Cancellation (group paper)
4. Number Cancellation (group paper)
5. Rhythm or Perception of Time (group apparatus)

It will be of interest to compare the authors' tentative classification of the tests with the functional classification discovered by the present writer's analysis.

The tests were administered to boys who were enrolled in the seventh and eighth grades of a Minneapolis junior high school and whose curriculum included the shop courses. A number of factors determined the selection of this particular group of subjects. Boys were chosen rather than men because it was felt that in boys individual differences would be determined less by differences in the amount of mechanical training and more by stable abilities which accrue from general sources. Boys from the middle class were selected rather than a more heterogeneous sample. The reason for this selection was that in all probability the boys in the upper classes have had a restricted opportunity to acquire mechanical abilities and the boys from the low, under-privileged class have had restrictions in their development, also. Selection of boys who were enrolled in shop courses was determined by the need for a suitable criterion which could not only be reliably determined but which would also suitably represent the varied operations which are considered to comprise mechanical ability. The battery of 26 tests required 11 hours of testing, and complete data were collected for 217 boys.

The Original Analysis of the Variables of the Preliminary Experiment

The authors of the Minnesota study were interested in the organization of mechanical ability because of its implication for this very practical question: Is it possible for an individual to be distinctly gifted in one line of mechanical work and to possess poor or mediocre capacity in others, i.e., is there a

mechanical ability or group of abilities? In their attempt to answer this question, they intercorrelated all of the variables employed in the preliminary experiment and then subjected these intercorrelations to analytical procedures. Since Spearman's theory of general ability, particularly with respect to intellectual functions, was one of the most arresting theories of the day, the authors concerned themselves principally with the task of finding evidence of a general mechanical ability.

In order to fulfill Spearman's demand that only dissimilar tests be subjected to scrutiny when a general factor is sought, the authors carefully examined their own tests and selected a group of 15 tests which were dissimilar to each other and were not correlated with each other to an exceptional degree. In light of current factor theory, the implications of this selective procedure are obvious. Similar tests are likely to be those highly intercorrelated and if several highly intercorrelated tests are encountered in a group of tests, we are certain to find a cluster or a factor. If such a cluster were found, it would not be possible to account for all of the inter-test correlations in terms of one general factor.

The intercorrelations of the selected 15 variables were arranged in the usual tabular form, and the inter-columnar correlations for this table varied from minus .68 to plus .81. It is obviously impossible to find any hierarchical order in such a table. A similar lack of hierarchical arrangement was encountered when the variables were corrected for attenuation. The results of this procedure combined with the results of certain preliminary procedures forced the authors to the conclusion that their data offered no evidence for a general factor in mechanical ability.

The authors then sought evidence for the existence of group factors. On a trial-and-error basis, attempts were made to construct hierarchies by arbitrarily selecting certain tests for grouping. This procedure was adopted because group factors are general within their own restricted field, that is, variables which define a group factor may be arranged in hierarchical order. The authors assumed that if several well-defined hierarchies were disturbed when tests from any other hierarchy

were included, the evidence would be strongly in favor of the existence of group factors, that is of mechanical abilities rather than a general mechanical ability. The writers reported that they found seven perfect hierarchies of four tests each. Two of these hierarchies were found to be mutually exclusive with respect to their component tests. The other five hierarchies drew upon the same tests. The writers do not indicate what variables contribute to all of the hierarchies. Since such hierarchies can be arbitrarily constructed without one's knowing to what degree they overlap, the analysis of the organization of mechanical ability provided by the Minnesota study leaves much to be desired. From their presentation it may be inferred that if a general mechanical ability factor is present, it is certainly not sufficient to account for all of the inter-test correlations. It may be further inferred that group factors do exist, but the degree of independence which they possess and their exact nature is in no way manifest.

A Factor Analysis of the Variables in the Preliminary Experiment[1]

The Minnesota investigators had employed numerous variables which are representative of if not identical with many in use today. Their population was quite large and in their attempts at the analysis of the organization of mechanical ability they determined the intercorrelations among all of the variables. An analysis of the Minnesota data using devices which were not then available is in order in two respects: (1) to round out the classic Minnesota investigation and (2) to shed light on the current problems of measurement of mechanical ability. As a consequence the intercorrelations of the Minnesota variables given in Table 1 were submitted to a centroid analysis; seven factors were extracted, six of which are given in Table 2. The centroid analysis was made for twenty-seven variables. The tests were the original list of twenty-six variables with the exception of the cube construction test, which was not intercorrelated by the Minnesota

[1] This analysis is concerned only with the variables employed in the preliminary experiment. In a forthcoming publication additional analyses of the Minnesota data will be reported.

TABLE I (S. 433)

Combined Intercorrelation of All the Tests Used in the Preliminary Experiment

TABLE 1 (5, 433)

Combined Intercorrelation of All the Tests Used in the Preliminary Experiment

	Age	Aiming	Army Alpha	Body Balancing	Card Assembling, Time	Cart Sorting, Time	Digit-Symbol	Letter Cancellation	Link's Mech. Operator's	Link's Spatial Relations, Both Boards	No. Cancellation	Otis Criterion Score	Packing Blocks	Paper Form Board	Rhythm	Slow Movement	Speed of Movement	Steadiness, No. of Contacts	Stenquist Assembly	Stenquist Picture I	Stenquist Picture II	Stick Balancing	Tapping A	Tapping B	Tapping C	Tracing Board No. of Errors	Tracing Paper No. of Errors
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
1																											
2	−.13																										
3	−.41	.16																									
4	−.09	.23	.11																								
5	−.05	.02	.07	.16																							
6	−.01	.17	.18	.20	.60																						
7	−.04	.22	.17	.18	.30	.38																					
8	.02	.08	.11	−.03	.21	.16	.32																				
9	.03	.13	.08	.22	.40	.40	.30	.18																			
10	−.06	.09	.21	.12	.23	.34	.22	.27	.19																		
11	.17	.05	−.08	.01	.21	.19	.33	.69	.20	.18																	
12	−.29	.10	.74	.11	.07	.22	.10	.05	.08	.22	−.08																
13	−.05	.07	.20	.13	.33	.38	.36	.28	.29	.36	.16	.20															
14	−.11	.06	.26	.05	.16	.18	.08	.10	.21	.51	.06	.28	.30														
15	−.14	.21	.13	.08	.10	.08	.12	.02	.03	.05	−.02	.07	.08	.04													
16	−.02	.12	.24	.07	.10	.01	−.02	.08	.07	.00	.10	.21	.14	.13	.01												
17	.12	.10	−.01	.06	.19	.12	.24	.22	.27	.13	.18	.00	.12	.10	.03	.05											
18	−.02	.11	.02	.08	.14	.06	.15	.13	.13	.04	.12	.02	.05	.01	.18	.09	.18										
19	.13	.09	.05	−.04	.11	.13	.00	.15	.12	.39	.08	.14	.17	.48	−.01	.02	.17	−.01									
20	.06	.02	.04	.06	.05	−.03	−.06	.04	.09	.28	.05	.03	.16	.37	.02	−.01	.04	.01	.48								
21	−.10	.03	.36	.09	.22	.14	.16	.25	.12	.49	.11	.37	.22	.58	−.01	.16	.11	.07	.55	.59							
22	−.01	.16	−.06	.32	.14	.17	.09	.01	.29	−.02	.03	−.02	.01	.07	.09	.05	.10	.03	−.06	−.08	−.09						
23	.09	.04	.03	.06	.14	.06	.19	.17	.11	.02	.14	.02	.05	−.01	.12	.04	.46	.14	.09	.02	.10	.08					
24	.34	.08	−.10	.06	.07	.07	.17	.03	.29	.01	.10	−.05	.12	.02	−.11	.00	.41	.01	.13	.03	.05	.10	.36				
25	.17	.09	−.03	.14	.15	.11	.21	.10	.27	.09	.11	.02	.15	.07	.01	.16	.25	.07	.10	.08	.17	.29	.29	.61			
26	.01	.08	.05	.10	.15	.23	.02	.07	.15	.18	.13	.06	.06	.16	.01	.10	.08	.33	.15	.10	.18	.11	−.04	−.11	−.02		
27	.03	.19	.05	.23	.02	.04	.12	−.06	.02	.00	.05	.01	.04	−.02	.01	.13	.08	.20	.04	.08	.11	−.05	−.01	.01	.05	.25	

authors with the other variables. This left twenty-five tests. The *Stenquist Picture Test*, however, really comprised two parts, I and II. Each was scored separately, correlated with the other variables separately, and the two parts are treated as two variables in the present study. Age was also included as a variable and thus the total list of twenty-seven variables which the present writer has analyzed is comprised.

TABLE 2

Centroid Matrix

	A	B	C	D	E	F	h^2
1	.00	.25	−.19	−.37	−.26	−.08	.32
2	.29	.06	.26	.14	.03	−.20	.21
3	.34	−.46	.35	.25	.43	.25	.76
4	.31	.09	.23	.26	−.22	−.09	.28
5	.50	.18	−.24	.31	−.10	.13	.46
6	.53	.12	−.22	.49	−.10	.20	.63
7	.48	.26	−.09	.22	.22	.09	.41
8	.44	.16	−.35	−.10	.48	−.25	.64
9	.50	.27	−.06	.17	−.15	.18	.41
10	.52	−.30	−.28	.08	−.02	.07	.45
11	.40	.28	−.38	−.13	.33	−.37	.64
12	.35	−.46	.31	.18	.29	.27	.62
13	.49	−.05	−.20	.18	.10	.15	.35
14	.48	−.47	−.17	−.04	−.11	.08	.50
15	.14	.06	.15	.20	.10	−.09	.10
16	.23	−.11	−.22	−.05	.10	−.08	.13
17	.44	.29	.10	−.27	.03	.11	.37
18	.27	.08	.23	.08	−.04	−.26	.22
19	.43	−.36	−.25	−.28	−.18	−.04	.48
20	.30	−.42	−.18	−.29	−.20	−.15	.44
21	.57	−.56	−.15	−.22	−.06	.05	.71
22	.20	.29	.15	.13	−.21	−.03	.20
23	.33	.32	.17	−.32	.14	.16	.37
24	.34	−.38	.08	−.44	−.16	.34	.55
25	.44	.29	.17	−.35	−.18	.23	.50
26	.30	−.11	.06	.17	−.27	−.32	.30
27	.19	−.04	.23	.05	−.11	−.27	.17

The centroid factors were orthogonally rotated according to the well-known principles of maximizing the number of zero loadings and minimizing the number of negative ones. After thirty-six sets of rotations had been made it was found that further rotations would contribute little to the simplicity of the patterns revealed. Each of the six orthogonal factors is well defined, and for the first five factors the loadings are exceptionally high. The rotated factor matrix is given in Table 3 and the transformation matrix is given in Table 4.

TABLE 3

Rotated Factor Matrix

		I	II	III	IV	V	VI	h^2
1	Age	.16	.28	−.44	−.04	.02	.19	.34
2	Aiming	−.12	.13	.07	.17	.11	−.33	.19
3	Army Alpha	.04	−.10	.85	.04	.11	−.02	.75
4	Body Balancing	−.10	.15	.12	.34	−.12	−.32	.28
5	Card Assembling, Time	.05	.10	.05	.66	.07	.08	.46
6	Card Sorting, Time	.02	.01	.17	.77	−.00	.09	.63
7	Digit-Symbol	−.12	.17	.18	.48	.31	.10	.41
8	Letter Cancellation	.08	.04	−.02	.23	.76	.06	.64
9	Link's Machine Operator's	.00	.31	.07	.55	.01	.05	.41
10	Link's Spatial Relations, Both Boards	.46	−.05	.22	.40	.15	−.09	.46
11	No. Cancellation	.06	.08	−.22	.26	.71	−.03	.64
12	Otis Criterion Score	.13	−.04	.77	.05	.03	−.02	.62
13	Packing Blocks	.18	.03	.24	.45	.19	.11	.35
14	Paper Form Board	.59	−.02	.28	.25	.04	−.07	.50
15	Rhythm	−.17	.00	.15	.14	.08	−.15	.10
16	Slow Movement	.05	.12	.24	−.02	.12	−.20	.13
17	Speed of Movement	.06	.55	.06	.15	.21	.04	.39
18	Steadiness, No. of Contacts	−.08	.15	.07	.14	.11	−.37	.21
19	Stenquist Assembly	.66	.10	.04	.13	.11	−.09	.49
20	Stenquist Picture I	.63	.12	.00	.00	.07	−.19	.44
21	Stenquist Picture II	.74	.06	.34	.15	.14	−.10	.71
22	Stick Balancing	−.17	.26	.06	.27	−.10	−.16	.21
23	Tapping A	−.05	.56	.09	.01	.23	.11	.39
24	Tapping B	.10	.73	.06	.07	−.00	.12	.56
25	Tapping C	.12	.69	.03	.13	.00	.04	.51
26	Tracing Board, No. of Errors	.14	−.01	−.01	.28	−.03	−.46	.31
27	Tracing Paper, No. of Errors	.00	.08	.06	.06	.02	−.40	.18

TABLE 4

Transformation Matrix

	A	B	C	D	E	F
I	.35	−.64	−.41	−.45	−.31	.04
II	.45	.49	.39	−.54	−.20	.24
III	.35	−.48	.51	.24	.41	.39
IV	.62	.25	−.35	.61	−.24	.08
V	.35	.15	−.27	−.23	.74	−.42
VI	−.21	.17	−.47	−.11	.29	.78

In order to clarify the implication of these factors, each will be discussed with respect to its component variables and with respect to the degree to which component variables are saturated with other factors.

Since the factors are discussed variable by variable, the data will be presented in the form of factorial equations.[2]

Factor I—Spatial Visualization

	I	II	III	IV	V	VI	U^2
10. Link's Spatial Relation	*.21*	.00	.05	.16	.02	.01	.55
14. Paper Form Board	*.35*	.00	.08	.06	.00	.00	.51
19. Stenquist Assembly	*.44*	.01	.00	.02	.01	.01	.51
20. Stenquist Picture I	*.40*	.00	.00	.00	.01	.04	.55
21. Stenquist Picture II	*.55*	.00	.11	.02	.02	.01	.29

The *Spatial Relations Test* of Link is the original form of the currently popular *Minnesota Spatial Relations Test.* The *Paper Form Board Test* from the *Army Alpha* is now modified and known as the *Minnesota Paper Form Board Test.* The *Stenquist Assembly Test* has been lengthened and modified and appears as the *Minnesota Mechanical Assembly Test.* Twenty-one per cent of the total variance of the *Spatial Relations Test* is due to the spatial factor. Another sixteen per cent of its variance is due to factor IV, which is identified as a dexterity factor. Users of the *Minnesota Spatial Relations Test* have long believed that this test calls for spatial ability and for a certain amount of dexterity or manipulative ability as well. The *Paper Form Board Test* has thirty-five per cent of its variance attributable to the Spatial factor; about eight

[2] Factorial equations are more revealing than simple factor loadings because they not only show how much of the total variance of a test is due to each factor, but they also indicate how much of the variance is not due to common factors, i.e., how much is unique (U^2) to the test in the present test sample: the values in the factorial equations are equal to the respective factor loadings squared.

per cent is due to factor III, which in this study is called the scholastic ability factor. The *Assembly Test* is largely a measure of spatial ability. It is very interesting to observe that it calls for the dexterity factor, IV, to a negligible degree. Contrary to the implications of its name, the *Assembly Test* calls for the ability to visualize the relations of parts rather than the ability to excel in the manual process of assembling parts.

Some explanation should be offered for the difference between the saturations of tests 20 and 21, both of which are Stenquist picture tests and contribute greatly to the spatial factor. It is observed that test 21 owes approximately 10 per cent of its total variance to the scholastic ability factor. A possible explanation of this difference between the two picture assembly tests is that test 21 was given under marked restriction of time. The time for each exercise in the test is reduced twenty per cent. The meaning of time restriction for this saturation of test 21 is a question that will be discussed further under factor III.

Factor II is determined by tests which appear to call for a high degree of speed in certain stereotyped ballistic movements of the wrist and forearm.

Factor II—Stereotyped Movement

	I	II	III	IV	V	VI	U^2
(9. Link's Mach. Operator)	.00	.10	.01	.30	.00	.00	.59
17. Speed of Movement	.00	*.30*	.00	.02	.04	.01	.63
23. Tapping A	.00	*.31*	.01	.00	.05	.01	.62
24. Tapping B	.01	*.53*	.00	.01	.00	.02	.43
25. Tapping C	.02	*.48*	.00	.02	.00	.00	.48

The *Speed of Movement Test* calls for as many vertical marks as possible within a time limit. Variables 23, 24, and 25 were all tapping tests which were conducted in different ways. In test 23, the individual is to make one dot in each of the large number of tiny squares. In test 24 he is to make as many dots as possible in each of the large squares outlined on his test paper, fifteen seconds allowed per square. In test 25, the individual is equipped with a metal plate and a stylus and his rate of tapping is determined. In all four of these tests the individual must make very rapid movements of the

wrist and the forearm. It is observed that test 9 had ten per cent of its total variance attributable to this factor. The machine operator's test, 9, involves dropping balls into a funnel at intervals which permit the ball to drop through a momentarily appearing aperture in a platform beneath the funnel. This performance calls for a vertical dropping movement of the hand which is not unlike the vertical movements called for in the various tapping tests.

Factor III is called the Scholastic Ability Factor for the simple reason that two well-known tests of scholastic ability comprise it.

Factor III—Scholastic Ability

	I	II	III	IV	V	VI	U^2
(1. Age)	.03	.08	−.20	.00	.00	.04	.65
3. Army Alpha	.00	.01	*.73*	.00	.01	.00	.25
12. Otis	.02	.00	*.59*	.00	.00	.00	.39
(21. Stenquist Picture II)	.55	.00	.11	.02	.02	.01	.29

These tests are the *Army Alpha* and the *Otis*. The scores are not intelligence ratios but are simply raw scores. As would be expected, this factor is negatively correlated with age. It will be remembered that the subjects for the preliminary experiment were picked from the seventh- and eighth-grade classes. Ordinarily the older children in a public school class are the children who have been retained, and most frequently this retention has been due to dullness on the part of the child. If this general observation may be validly applied here it accounts for the negative relation between this factor and age. It is further observed that variable 21, the *Stenquist Picture Test II,* has a probably significant relationship with this factor. The next variable most highly correlated with this factor is variable 14, the *Paper Form Board Test.* The *Army Alpha,* the *Otis,* the *Paper Form Board,* and the *Stenquist Picture Test II* are all pencil-and-paper tests which may be classified as mental tests and all four are highly speeded. Perhaps these common characteristics can account in part for the positive intercorrelation.

Factor IV is determined by tests which appear to call for a type of manual dexterity.

Factor IV—Manual Dexterity

	I	II	III	IV	V	VI	U^2
(4. Body Balancing)	.01	.02	.02	.11	.02	.01	.72
5. Card Assembly, Time	.00	.01	.00	*.43*	.01	.01	.54
6. Card Sorting, Time	.00	.00	.03	*.60*	.00	.01	.36
7. Digit-Symbol	.02	.03	.03	.23	.10	.01	.58
9. Link's Mach. Operator	.00	.10	.01	*.30*	.00	.00	.59
10. Link's Spatial Relation	.21	.00	.05	.16	.02	.01	.55
13. Packing Blocks	.03	.00	.06	*.21*	.04	.01	.65

Variables 5 and 6 are the best measures of this factor and they are the well-known Card Sorting and Card Assembly tests. The next best test appears to be test 9, which is the *Machine Operator's Test* described in the discussion of Factor II. Tests which have correlations of approximately .30 or greater with this factor tend to contribute to its meaningfulness; variables 4 and 7 are possible exceptions. There is no apparent reason why variable 4 should be expected to correlate with the factor of manual dexterity, and it is somewhat surprising although not wholly unreasonable to find a test of digit-symbol-substitution highly correlated with the dexterity factor. The exact nature of the manual dexterity factor is not perfectly clear. To what degree excellence of performance on tests of this factor is due to a type of acuity of perception and recognition has not been determined. This question will be discussed further with presentation of Factor V. Test 10, the *Spatial Relations Test,* which owes sixteen per cent of its variance to this factor, obviously requires manipulative skill and would be expected to draw upon some sort of manual dexterity to a significant degree.

Factor V is identified by tests which have been termed perceptual tests and have been found by previous investigation to determine a perceptual factor (9).

Factor V—Perceptual Factor

	I	II	III	IV	V	VI	U^2
(7. Digit-Symbol)	.02	.03	.03	.23	.10	.01	.58
8. Letter Cancellation	.01	.00	.00	.06	*.57*	.00	.36
11. Number Cancellation	.00	.01	.05	.07	*.51*	.00	.36

The two cancellation tests, no. 8 and 11, have remarkably high saturations with this factor. Test no. 7, the *Digit-Symbol Substitution Test,* has unexpectedly low saturation. The reason for this test's having a high saturation with the

dexterity factor rather than with the perceptual factor may actually be due to an undetected clerical or computational error. On the other hand, it is conceivable that the relations observed here are valid relations and perhaps some unrecognized aspect of the digit-symbol performance could, if understood, give insight into the nature of manual dexterity. It should be observed in passing that tests commonly employed in the measurement of perceptual ability, including cancellation tests such as appear in this battery, call for speed of simple, routine perception and the emphasis is not upon acuity of differential recognition and discrimination. Perhaps manual dexterity is a complex ability which does call for a differential recognition and discrimination which is not purely or primarily of a routine nature. The hypothesis that tests for manual dexterity draw upon two distinct abilities, a manipulative ability and a recognition ability, may be tested by determining the factorial composition of manipulative tests when given in a darkened room or under conditions to eliminate visual discrimination and comparing the results with the factorial composition of these tests when they are administered under ordinary conditions. Factor analysis is not necessary to test this hypothesis, however, and other, simpler designs would undoubtedly be more economical.

Factor VI has low saturations. The relatively low intercorrelations among the tests which contribute to the steadiness factor are in part due to their unreliability. The tests with the highest loadings have certain common characteristics, and as a consequence the factor of steadiness has been hypothesized.

Factor VI—Steadiness

	I	II	III	IV	V	VI	U^2
2. Aiming	.01	.02	.01	.03	.01	*.11*	.81
4. Body Balancing	.01	.02	.01	.11	.01	*.10*	.74
18. Steadiness, No. contacts	.01	.02	.01	.02	.01	*.14*	.79
26. Tracing Board, No. errors	.02	.00	.00	.08	.00	*.21*	.69
27. Tracing Paper, No. errors	.00	.01	.00	.00	.00	*.16*	.83

Body Balancing calls for the individual's balancing himself on the ball of one foot while standing on a three-inch cube of wood. Buxton (2) reported a factor of manual steadiness based upon two tests, one of which was a thrusting test which

calls for an operation similar to the nine holes steadiness test. In a later paper, Seashore *et al.* (7) reported a steadiness factor which was based upon measurements of postural sway. The steadiness factor which is reported in this study is dependent upon a measure of postural steadiness, body balancing, as well as measures of manual steadiness. These data in combination with the data provided by other observers (4, 6, 8) suggest that there is one general steadiness factor (probably due to basically physiological individual differences conceivably in proprioceptive sensitivity or muscular tonus). The possibility that there exists only one general factor of steadiness has quite useful implications and the hypothesis may readily be tested.

The conclusion is apparent from this analysis that no common factor could account for the intercorrelations among the various tests. On the contrary it is apparent that the inter-test correlations may be accounted for in terms of six independent and meaningful factors. Obviously such factors cannot be considered immutable or part of the universe, but among tests which the authors of the Minnesota study (as well as current investigators) consider to be important and representative, meaningful, well defined, independent, functional groupings have been demonstrated.

Other Analyses of Mechanical Ability

There are few factorial studies relating to mechanical ability reported in the literature; the most satisfactory one is Harrell's, which he succinctly summarizes as follows: "The intercorrelations of thirty-seven variables, including the Minnesota battery of 'mechanical ability' tests, the seven MacQuarrie tests of 'mechanical ability,' O'Connor's Wiggly Blocks, and the Stenquist picture-matching test, were analyzed by Thurstone's centroid method. Five factors, Perceptual, Verbal, Youth, Manual Agility, and Spatial, were taken out. Factors prominent in so-called mechanical ability tests are the Spatial and Perceptual ones with MacQuarrie's dotting test significantly high in the Manual Agility factor. Each of the factors can be measured with group pencil-and-paper tests"

(3). Harrell's Factor IV, agility, could readily be identified with the present writer's manual dexterity factor, IV, were it not for the participation of the dotting test in Harrell's agility factor. Since there were no additional dotting tests in his battery or other tests of the ballistic type, we cannot be confident that the loading of the agility factor with this particular test has general significance. It may be suspected that this test is highly related with a "ballistic" or stereotyped movement factor; high correlations between MacQuarrie's dotting and tapping tests have been reported (1).

In "*The Application of Multiple Factorial Methods to the Study of Motor Abilities*" (2) Buxton found several factors which are in essential agreement with the results of the present study. His Factor I is a dexterity factor which appears to be identical with the dexterity factor described in the present study. His Factor III, a steadiness factor, is determined by manual tests only. Buxton's Factor VI is found in neither the present study nor in Harrell's study. It appears to call for general coordination of the muscles of the forearm, upper arm, and shoulder girdle.

A "*Multiple Factorial Analysis of Fine Motor Skills*" by Seashore, Buxton, and McCollom has been reported (7). The results of this study have uncertain value for the broader problem of mechanical ability for several reasons. The tests employed are of a rather specific nature and may not in general be considered representative of tests for mechanical ability. The analysis was based upon a sample of 50 men, a small sample for factor analysis. Moreover, it appears likely that the authors might have extracted additional factors; from an examination of the factor matrix it does not appear that the zero-order correlations may be satisfactorily reproduced. As the writers themselves note, some of the factor loadings are inconsistent with the identifications of the tests and factors. Although the study was not intended to contribute directly to the problem of the nature of mechanical ability, it does support the implications of the present study by suggesting the existence of a postural steadiness factor and a factor of stereotyped movements of the arm such as are called for by Factor III in the present study.

The literature offers several interesting studies of the organization of strength, agility, and motor fitness. In a comprehensive approach to the study of the nature of mechanical ability, cognizance must be given to such possible components. This aspect of mechanical ability will be treated in a forthcoming study.

Discussion

The occurrence of an orthogonal factor structure is of some interest because both Buxton and Harrell have found an oblique structure to be most appropriate in analyzing their variables. The orthogonal feature of the present analysis may be in part due to the age of the subjects. They are seventh- and eighth-grade boys; the subjects for the other analysis of Buxton and Harrell had been adults. Babcock and Emerson, in a study of MacQuarrie's test for mechanical ability, have found intercorrelations among the subtests to increase in magnitude with age of subject (1). This interesting tendency is quite the reverse of that usually observed for the so-called mental tests. The tendency for mental abilities as defined by factor analysis to become increasingly independent of each other with increasing age and the apparent tendency of mechanical abilities to become more highly related with each other with increasing age requires explanation, and it is possible that the final answer to this paradox may yield some insight into the nature of the respective classes of ability. Since all the mechanical tests employed in this study (and in other studies too) are not equally valid, it cannot be argued that excellence in practical mechanical work requires a high degree of all of these abilities and that therefore a type of automatic selection occurs which eventually results in those who have a high degree of all abilities being active in mechanical operations and those deficient in any one being equally discouraged in all. It is not likely that any selective situation such as this can be invoked to explain this paradoxical trend. A slightly modified hypothesis may be offered, however; namely, that a high order of spatial ability is necessary for personally gratifying performance in any mechanical operation and that persons who are deficient in spatial ability may in general tend to

avoid mechanical work or participate with little zeal and as a consequence neglect the development of any purely manual facilities with which they might have started life. The apparent anachronism in the development of mechanical ability is provocative of speculation. Although the trend may not be verifiable its implications are important enough to warrant scrutiny of any suitable genetic records which may exist.

It is of interest to compare the classification of the tests arbitrarily imposed by the authors at the beginning of the Minnesota investigation and the classification revealed by the empirical evidence offered by the intercorrelations and by subsequent factor analysis. The first arbitrary classification was Intelligence and this classification is validated by the results of the statistical analysis. The second classification, Simple Motor Tests, actually includes measures for two factors defined by the present factor analysis, i.e., Factors I and III, stereotyped movement and steadiness. The third group comprises the two balancing tests and is also included in the steadiness factor. The fourth group, Complex Eye-Hand Coordination Tests, comprises tests which determine Factor IV, identified in the present study as manual dexterity. The participation of the *Digit-Symbol Substitution Test* and of other measures in this factor suggests that the designation eye-hand coordination for this class of ability may be most appropriate. As previously mentioned, however, further research is required before the exact nature of manual dexterity can be determined. It may well be that manual dexterity is an operational unit which when analyzed for logical content does demand a type of manipulative ability and visual discrimination. It is equally possible, however, that manual dexterity or eye-hand coordination may be fractionated into two relatively independent components, visual discrimination and a manipulative ability. Group V, designated as Assembly Tests Involving Manipulation and Response to Spatial Relations, appears to be appropriately identified insofar as our analysis has revealed that these tests, though primarily dependent upon the spatial visualization ability, draw in varying degrees upon manual dexterity. This class probably was regarded as a

combination group, however; i.e., it is not apparent that the Minnesota authors foresaw that such tests as the *Spatial Relations Test* and the *Assembly Test* would be primarily determined by the same factors as the *Paper Form Board Test.* Demonstration that spatial ability is a primary component of such manual tests as the *Stenquist Assembly* as well as the *Paper Form Board Test* was probably first made by Harrell. The *Stenquist Picture Tests,* set aside in a separate class as requiring mechanical knowledge, are found actually to contribute to the spatial factor. Apparently the perceptual factor was entirely unanticipated by the Minnesota authors; the cancellation tests are classified under miscellaneous.

Summary

The present study comprises a review of the preliminary Minnesota experiment and a factorial analysis of the variables. The analysis reveals that interrelationships of the variables are of such a nature as to yield upon analysis six meaningful independent factors. For the most part the loadings are exceptionally high and the results of the analysis are exceptionally definitive. The factors are:

I—Spatial Visualization
II—Stereotyped Movement
III—Scholastic Ability
IV—Manual Dexterity
V—Perceptual—Speed
VI—Steadiness

REFERENCES

1. Babcock, H. and Emerson, M. R. "An Analytical Study of the MacQuarrie Test for Mechanical Ability." *Journal of Educational Psychology,* XXIX (1938), 50–55.
2. Buxton, C. "The Application of Multiple Factorial Methods to the Study of Motor Abilities." *Psychometrika,* III (1938), 85–93.
3. Harrell, W. "A Factor Analysis of Mechanical Ability Tests." *Psychometrika,* V (1940), 17–33.
4. Humphreys, L. G., Buxton, C. E., and Taylor, H. R. "Steadiness and Rifle Marksmanship." *Journal of Applied Psychology,* XX (1936), 680–688.
5. Patterson, D. G., Elliott, R. M., Anderson, L. D., Toops, H. A., Heidbreder, E. *Minnesota Mechanical Ability Tests.* The University of Minnesota Press, Minneapolis, 1930.

6. Seashore, R. H. and Adams, R. D. "The Measurement, Steadiness: A New Apparatus and Results on Marksmanship." *Science,* LXXVIII (1933), 285.
7. Seashore, R. H., Buxton, C. E., and McCollom, I. N. "Multiple Factorial Analysis of Fine Motor Skills." *American Journal of Psychology,* LIII (1940), 251–259.
8. Spaeth, R. A. and Dunham, G. C. "The Correlation Between Motor Control and Rifle Shooting." *American Journal of Psychology,* LVI (1921), 249–256.
9. Wittenborn, J. R. "Factorial Equations for Tests of Attention." *Psychometrika,* VIII (1943), 19–35.

SUGGESTIONS FOR THE CONSTRUCTION OF MULTIPLE-CHOICE TEST ITEMS

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IN WRITING items in a particular area it is possible, but not very profitable, to use the inspiration technique. One reads until he is inspired to write an item, jots it down, and then reads some more. Those concepts that fall readily into item form get tested over and over again; those more difficult to test go untested. This procedure is likely to result, among other things, in very spotty coverage of the subject-matter area. In writing items, as in other activities, planning is essential.

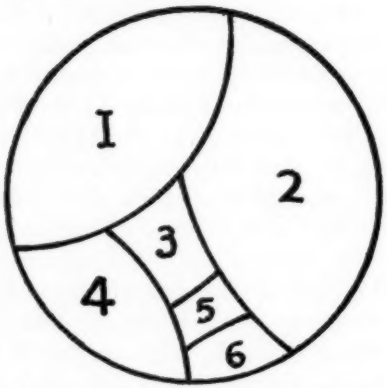
The present paper presents three work tools for the construction of multiple-choice items: definition of the subject-matter area to be covered and systematic sampling of it; a check list of the kinds of questions which can be asked; and a summary of criteria for multiple-choice items.

Although these materials were developed for use in examining for public personnel selection, they are applicable, with minor changes, in the other fields of test construction.

To cover a subject-matter area adequately, whether in educational testing, merit system examining, or aptitude testing, the first step should be a definition of the area or areas to be tested. Even in a limited field, all possible questions cannot be asked; it is necessary to resort to a sampling of the field. If, however, the individual's performance on the sample is to represent his performance in the entire field, it is a truism that the sample must represent the field; the sample to be representative cannot be left to chance, but should be planned. The definition of the field states the limits which must be reached; it does not prohibit going beyond those limits. If items are written outside the boundary of the definition, they

can usually still be used; if no items are written on an area within the field, that part of the area has not been sampled. A picture may help to visualize this.

The entire circle represents the particular subject-matter area, e.g., knowledge of elementary and intermediate statistics. Each subdivision represents a set of related concepts within the broader field. For example, *1* might be the concepts relating to frequency distributions; *2* those relating to central tendency; *3* those relating to dispersion, etc. Unless the total area is defined by correctly drawing the total circle, e.g., closing the circle in the lower right quadrant, the existence of the sixth subdivision escapes our attention.



It is essential, if one is to test adequately for a knowledge of the principles and techniques in statistics, that he be prepared to include test items in each of the areas. It is not necessary to include one from every area in every examination; one should not, however, include three from section *1* and none from section *6* unless he is prepared to say that the concepts in *1* are very important and those in *6* are inappropriate to the purposes of the particular examination.

After the area has been outlined, the next step is the identification of its significant subdivisions. This can be accomplished by listing the important concepts, topics, principles, or subdivisions of the field or of the various types of skills which contribute to the total. This list represents the specifications

for the set of items. It should not, generally, be a list of the items to be written, but of the sub-areas to be covered, with each area to be sampled by several items. Preparing such a list assumes either an authoritative outline already set up, or an over-all familiarity with the field. The chapter headings in a text or the paragraph headings within a chapter constitute one source of such a listing. Once made the list is important: first, as an index to the resulting assembly of items; second, as a guide to future item construction; and third, as a more elaborate definition of the types of items contained in the subject-matter area. Table 1, showing an outline of statistics, is presented as an illustration, not necessarily as a model.

TABLE 1
Outline of Statistics

1. General
   - Interpretations
   - Life Tables
   - "Severity Rate"
   - Simple computations
   - Sources and bibliographies
   - Tabular presentation of results
   - Terms and symbols
   - Planning surveys
   - Compound interest formula
2. Frequency Distributions
   - Class intervals and limits
   - Bimodality
   - Symmetry
   - Skewness
   - Frequency polygon
   - Kurtosis
   - Percentiles
   - Normal curve properties
   - Binomial expansion
3. Charts, Graphs and Index Numbers
   - Ogive
   - Moving average
   - Straight-line equation
   - Semi-log paper
   - Interpolation and extrapolation
   - Pictograms and circle diagrams
   - Gantt, Lorenz, ratio, and time charts
   - Graphic computation
   - Index numbers
4. Central Tendency
   - Mean
   - Median
   - Mode
   - Harmonic Mean
   - Geometric Mean
5. Dispersion
   - General
   - Sigma
   - Average deviation
   - Quartile deviation
6. Correlation
   - Interpretation and use
   - Scatter diagram
   - Pearson
   - Other coefficients
   - Regression lines
   - Partial and multiple
   - Coefficient of alienation
   - Standard error of estimate
7. Non-Linear Regression
   - Trend lines
   - Population curves
   - Eta and Blakeman's test
8. Sampling
   - Methods: random, weighted
   - Sampling errors
   - Interpretation, S.E., and C.R.
   - Combination of samples
   - Probability theory

Once the list of concepts, principles, skills or topics to be tested has been completed, appropriate sources or sections of the source should be used in constructing the items.

It is useful to distinguish between the concept, or the skill, being tested and the kind of question asked to test that concept. A further distinction which should be made is between the kind of question asked (e.g., what, why, who?) and the form of the test item used to ask the question (e.g., true-false, multiple-choice, completion). We are concerned here primarily with multiple-choice items and the *form* of the test item will not be considered further. In Table 2 is a check list of some of the kinds of questions which may be asked together with illustrative examples based on the concept of central tendency.

TABLE 2

Types of Questions

1. Definition

a. What means the same as . . . .
b. What conclusion can be drawn from . . . .
c. Which of the following statements expresses this concept in different terms?
   Example: The value which is determined by adding all of the scores and dividing by the number of cases is known in statistics as the:
   (1) arithmetic mean;
   (2) median;
   (3) mode;
   (4) harmonic mean;
   (5) average deviation.

2. Purpose

a. What purpose is served by . . . .
b. What principle is exemplified by . . . .
c. Why is this done . . . .
d. What is the most important reason for . . . .
   Example: The mean is obtained for the purpose of providing:
   (1) a single number to represent a whole series of numbers;
   (2) the central point in a series;
   (3) a measure of group variability;
   (4) an indication of the most frequent response given;
   (5) an estimate of the relationship between two variables.

3. Cause

a. What is the cause of . . . .
b. Under which of the following conditions is this true . . . .
   Example: From which of the following measures of central tendency will the sum of the deviations equal zero?
   (1) the mean;
   (2) the mode;
   (3) the median;
   (4) an arbitrary origin;
   (5) any measure of central tendency.

4. Effect

a. What is the effect of . . . .
b. If this is done, what will happen?
c. Which of the following should be done (to achieve a given purpose)?

Example: The arithmetic mean of 55 cases is 83.0. If 3 of the cases, with values of 82, 115, and 130 are deleted from the data, the mean of the remaining 52 cases will be: (1) 81.50; (2) 77.05; (3) 83.00; (4) 84.50; (5) 94.08.

5. Association

What tends to occur in connection (temporal, causal or concomitant association) with . . . .

Example: If the distribution of scores is skewed positively, the mean will be:
(1) lower than the median;
(2) the same as the median;
(3) higher than the median;
(4) relatively unaffected;
(5) the same as the mode.

6. Recognition of Error

Which of the following constitutes an error (with respect to a given situation)?

Example: The mean should not be used as the measure of central tendency when:
(1) the distribution of scores is significantly skewed;
(2) there are a large number of cases;
(3) a non-technical report is to be prepared;
(4) the data are continuous;
(5) other statistical formulae are to be computed.

7. Identification of Error

a. What kind of error is this?
b. What is the name of this error?
c. What recognized principle is violated?

Example: In computing the mean of a distribution from grouped data, the sums of the deviations above and below the arbitrary origin were found to be 127 and 189, respectively. The final value for the mean was in error. Of the following possibilities, that one which is most likely to have caused the error is that the computor:
(1) failed to note the correct sign in adding the mean of the deviations to the assumed origin;
(2) used an assumed mean higher than the true mean;
(3) omitted some of the cases in tabulating the data;
(4) divided by the wrong number of cases;
(5) multiplied by the wrong class interval value.

8. Evaluation

What is the best evaluation of . . . (for a given purpose) and for what reason?

Example: When the number of cases is small, e.g., less than 20, and the magnitude of the values is likewise small, the use of an assumed mean in the computation of the mean can best be evaluated as:
(1) less efficient than computation from actual values;
(2) likely to distort the value obtained by the introduction of a constant error;
(3) more accurate than the use of actual values;
(4) neither better nor worse than computation by other methods;
(5) applicable only if the distribution is reasonably symmetrical.

9. Difference

What is the important difference between . . . .

Example: Of the following statements, that one which characterizes the essential difference between the mean and the median as measures of the central tendency of a distribution is that:

(1) the magnitude of each score does not contribute proportionately to the computation of the median but does for the mean;
(2) the median is a point whereas the mean is a distance;
(3) the mean is less affected by extreme values;
(4) the median is easier to compute;
(5) the median is more generally used.

10. Similarity

What is the important similarity between . . . .

Example: The mean and median are the same in that they are both measures of:

(1) central tendency;
(2) distance;
(3) position;
(4) variation;
(5) relationship.

11. Arrangement

In the proper order, (to achieve a given purpose or to follow a given rule) which of the following comes first (or last or follows a given item)

Example: In computing the mean for data already grouped in class intervals the most efficient first step is to:

(1) determine the arbitrary origin and enter the deviation values;
(2) find the midpoints of the class intervals;
(3) multiply the frequency in each interval by the midpoint of the interval;
(4) add the column of scores;
(5) find the reciprocal of the total number of cases.

12. Incomplete Arrangement

In the proper order, which of the following should be inserted here to complete the series?

Example: In deriving the formula for computing the mean from grouped data using an arbitrary origin the following steps were taken:

a. $X' = \frac{X - A}{i}$;

b. $\Sigma X = i\Sigma X' + NA$;

c. $\frac{\Sigma X}{N} = A + \frac{i\Sigma X'}{N}$.

The step which is implied between steps (a) and (b) is:

(1) solving (a) for X;
(2) summing (a) over the N cases;
(3) multiplying by i;
(4) adding A to both terms of (a);
(5) dividing by N.

13. Common Principle

All of the following items except one are related by a common principle:

a. What is the principle?
b. Which item does not belong?
c. Which of the following items should be substituted?

Example: All except one of the following items (arithmetic mean, median, mode, and quartile) are measures of central tendency; of the following statistics, that one which could be substituted in the series for the item improperly included is the:

(1) harmonic mean for quartile;
(2) average deviation for mode;
(3) range for quartile;

(4) standard deviation for quartile;
(5) 50th percentile for median.

14. Controversial Subjects

Although not every one agrees on the desirability of ———, those who support its desirability do so primarily for the reason that:

Example: Although not every one agrees that the mean is the best measure of central tendency, those who advocate its general use base their recommendation on the fact that the mean:
(1) has the smallest sampling error;
(2) is easiest to compute;
(3) is most readily understood;
(4) is the most typical score;
(5) is not affected by extreme values.

Frequently a concept can be tested by a variety of questions; for some concepts only one kind of question is appropriate; for still others, several are applicable, but one or two are clearly most appropriate. To secure adequate sampling in the construction of items on any concept, the concept should be checked against the list and as many items written as seem appropriate, each asking a different kind of question. By writing items which test knowledge of a concept through several kinds of questions, it is frequently possible to sample the area at several levels of difficulty, ranging from the simplest to the most difficult.

The construction of a number of different items on each concept included in the outline of the subject-matter field provides a more effective means of meeting the objective of those who feel that internal weighting is essential to give the appropriate emphasis to the more important concepts. The proponents of internal weighting argue that since certain concepts are more important, extra credit should be given for the questions on those concepts. If the desirability of such extra credit is granted, the weighting is more easily and more reliably accomplished by including extra questions than by doubling the credits for a single question, thereby doubling the effect of measurement errors in the question. The availability of several different questions on each concept makes it possible to include more than one for any that are considered more important. These considerations apply whether items are being constructed for a single examination or for a central file.

The check list, *Types of Questions,* in Table 2 is not in-

TABLE 3

Criteria for Constructing Multiple-Choice Items[1]

I. General Validity
   1. Can we readily predict that those candidates who know the answer would, on the average, be better qualified for the purpose at hand than those who do not?
   2. Is the item thought-provoking, rather than calling merely for scraps of information?

II. Item Content
   1. Is the content of the item important enough to justify a question—not so specialized that only a few highly selected experts could know the answer?
   2. Does the subject matter of the item appear to be reasonably related to some type of activity appropriately covered by the test?
   3. Are the subject matter and the phrasing of the item such that no emotional antagonism will be aroused on the part of the public and the candidate? How would the item look in a newspaper unfriendly to the merit system? (Although this criterion is primarily formulated for merit system examiners, it has application in education testing; there is no need to antagonize students unduly in testing them.)
   4. Is the content of the item something which can be learned without having actually been on the job itself?
   5. Does the subject matter mirror a consensus of current authoritative beliefs and opinions, rather than the opinion of one individual?
   6. Could general terms be used to make the item usable in more than one testing situation. If the principle is applicable only in one situation, has this fact been flagged by specific reference in the item?
   7. Does the item call for a knowledge of concepts, reasons, and relationships, rather than for mere factual information, whenever the former is appropriate?
   8. Could any part of the item, such as modifying phrases, qualifications, etc., be omitted without significantly influencing the distribution of responses?

III. Item Structure
   A. Premise
      1. Is a definite task clearly and unambiguously set, so that all candidates work on essentially the same problem? Is it sufficiently clear that an informed candidate could give the correct answer from the premise if it were written as a completion item with no choices given?
      2. Is the idea stated clearly and directly, with the answer an important part of the statement—not buried at the end of a preposition in a parenthetical "which clause"?
      3. Does the premise, combined with each choice, constitute a complete unit of thought, both ideologically and grammatically?
      4. Does the premise, combined with the right answer, constitute a definite and true concept? Is the premise phrased to require something more (the correct choice) for completeness?
      5. If the question is stated negatively, can it be restated in positive terms? If not, has the attention of the candidate been directed to-toward the negative phrasing of the question?
      6. Is the premise phrased to ask for the best rather than the correct answer whenever possible?
      7. Is the premise stated so complexly that the item becomes a test of whatever is taken to understand a complex premise rather than a test of knowledge or reasoning? If so, is this what was intended?

[1] These criteria, stated in terms of merit system examining, can be made applicable to other testing situations by appropriate changes in wording.

TABLE 3

Criteria for Constructing Multiple-Choice Items

8. Does the premise avoid all unnecessary content which might give away the answers to other items?
9. If there are other answers conceivably as good as the intended answer, is the premise limited by the phrase, "of the following"?

B. Correct Answer

1. Is there one and only one correct answer to the problem as set by the premise? If the intended answer is merely the best of those given, is this indicated clearly in the premise?
2. Do competent authorities agree on the correct answer?
3. Could the candidate distinguish the correct answer from the incorrect answers without having read the premise? If so, the item is in need of revision.
4. Does selecting the correct choice require a real or reasoned understanding of the concept rather than mere recall or recognition?
5. Is there no possibility that a candidate may select the correct response simply because it is the only one containing the same words or phrases as the premise or because of other external characteristics?

C. Distracters

1. Are the distracters such that a person likely to be inferior on the job will think they are correct? Is each distracter so plausible that someone not knowing the correct answer will choose it?
2. If there are popular misconceptions in the field, are the distracters designed to attract candidates holding those misconceptions? Can familiar or stereotyped phrasing in the distracters be used to make them sound plausible? Can words or phases similar to those in the premise be deliberately planted in the distracters to give them added plausibility? Can this increased plausibility be achieved without distracting too many of the qualified candidates as well? Are specific determiners, such as "always" or "never," avoided?
3. Are are distracters, as well as the intended answer, related to the premise, both ideologically and grammatically?
4. Are there no distracters so nearly correct that well qualified persons are likely to accept them and be able to defend their answers?
5. Can the question be answered by someone who knows, not that the intended answer is correct, but that the incorrect choices are obviously wrong? If so, does the item remain at the difficulty level originally intended?
6. Do all the choices constitute possible answers to a single direct question implied in the premise?
7. Are the distracters of about the same length and complexity as the correct answer? If not, are there at least two which are parallel with the intended answer?
8. Do pronouns refer clearly to one and only one antecedent?
9. Are the choices parallel in grammatical form and in meaning?
10. Are there repetitions in the choices which could be avoided by putting the repeated thought into the premise?

tended to be all-inclusive nor is it intended to prescribe the language to be used in asking any particular kind of question. Rather it is a guide to assist in formulating questions and a check to help insure that all of the appropriate kinds of questions will be asked.

Once the concept to be tested and the kind of questions to be asked have been determined, there remains the task of framing objective questions which will accomplish the intended purpose.

The task can be stated simply: To phrase a question in such terms that (a) all prospective examinees understand the task set; (b) those who have the requisite degree of knowledge will give the intended answer; and (c) all who do not will give another answer. Fashioning such an item is more difficult than formulating the problem. The criteria in Table 3 are set up as aids in constructing such items. They are by no means original; they have been assembled from various sources and are summarized here for convenience. The criteria in the table were formulated for use in merit system examining; each one, however, with slight changes in wording or in emphasis is applicable in other examining settings. These criteria should be applied to each item written; the item should not be considered as complete until the writer is satisfied that it meets each criterion.

After the concept has been identified, the question asked in a premise which is clear and the intended choice written, the next task is that of writing distracters. The ideal distracters are those wrong answers actually given by representatives of the group for which the item is intended (not by some other group), in response to the question asked as a completion item. Since item writers do not normally have ready access to such answers, it is up to them to project themselves into the situation and say, "If I were one of the group to whom this test is to be given and were asked this question as a completion item and didn't know the answer, what response would I give?" On the success with which the item writer can thus project himself into the situation of such candidates and predict their responses rests the value of the item from a technical standpoint.

In presenting a completed item the item writer is, in effect, saying: "This item is to be included in a test and given to a group of examinees, some qualified and some not qualified with respect to a particular objective. If we could accurately separate the qualified individuals from the unqualified, and

examine the responses of each group, we would find the keyed answer given by a relatively high proportion of the qualified group and by a low proportion of the unqualified. Each of the four distracters, on the other hand, should be given by a high proportion of the unqualified group and by a low proportion of the qualified." If, after finishing an item, one cannot in all honesty make this prediction, the item should be worked on further. If this prediction can be made, it still needs empirical verification by observing the actual responses of the two groups, "qualified" and "unqualified," as defined by an acceptable criterion.

INFLUENCE OF LEVEL OF MOTIVATION ON THE VALIDITY OF INTELLIGENCE TESTS

L. D. HARTSON
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A TOTAL of 579 students entered Oberlin College during the period 1941–43 for whom IQ's were available from tests taken previous to entering college. These data have been added to those for the group of 734 entering during the years 1934–40, concerning whom a report has previously been made (2), making a total of 1,313 students. These data have been studied for the purpose of checking the earlier results, and examining the relationship between aptitude and scholastic achievement at different levels of motivation.

Follow-Up of Study Reported in 1941

From these 1,313 students a total of 1,444 records are available, since there are 131 cases for whom two IQ figures were reported. For some purposes these might have been averaged, but as that would have prevented their use for comparing the validity of the different varieties of test, each IQ has been treated as though it represented a different student. The same procedure being followed with those who became seniors, the records for 522 students yielded 577 IQ's. The two populations employed in the study are, therefore, 1,444 and 577. The figures used in the computation of high-school scholarship represent not the actual grades but "credit points" obtained by a system for equating different grading systems. College scholarship is handled in centile scores, that for seniors representing the cumulative average for seven semesters.

Correlations were computed (1) between IQ's obtained from the following group tests: *Otis, Terman, Henmon-Nelson, National, Kuhlmann-Anderson,* from the individually adminis-

TABLE 1

Correlations between IQ's Derived from Various Tests and (1) High-School Scholarship, (2) 1st-Semester College Scholarship, and (3) OSU Test Scores.

Test	N	Scholarship		Fresh. week *OSU Test*	Test scores		Scholarship			
		High-school	1st-sem. college		Mean	σ	High-school		1st-sem. college	
							Mean	σ	Mean	σ
Otis	680	.328	.360	.513	120.10	8.50	76.49	17.94	48.71	27.91
Terman	304	.285	.390	.542	122.64	10.62	76.34	16.74	49.64	27.73
Henmon-Nelson	258	.385	.404	.536	123.83	9.19	81.68	14.69	50.62	25.44
National	48	.339	.301	.478	129.25	12.52	82.83	12.85	53.42	23.62
Kuhlman-Anderson	63	.250	.165	.396	124.75	11.69	76.56	18.19	55.02	29.73
Stanford-Binet	91	.259	.343	.566	123.66	12.90	71.80	20.14	48.46	30.69
OSU (Pre-Entrance)	331	.349	.511	.774	55.35	26.68	69.02	22.57	41.78	30.45

tered *Stanford-Binet,* and from the *Ohio State University Psychological Examination,* as one variable, and high-school scholarship, as one criterion; (2) between all of these tests and first-semester college scholarship, as a second criterion; (3) between the IQ's on each of these test groups and the *OSU Test* scores. A comparison was also made (4) of the validities of the *OSU Test* scores and those obtained with each of the other tests, with scholarship used as the criterion at both the secondary school and college levels.

The Prediction of High-School and College Scholarship

The results obtained with 1,444 students in general confirm those reported for the smaller group, as may be seen by comparing Tables 1 and 2 with the corresponding tables in the 1941 study. The group tested with the *Henmon-Nelson Examination* again shows a higher validity than do the other tests yielding IQ's (Table 1), even though this group yields a lower validity coefficient than do the students tested with the *Kuhlmann-Anderson* and with the *Stanford-Binet,* when their intelligence is measured by the *OSU Examination* (Table 2).

TABLE 2

Correlations between Various Tests and Scholarship

Test group	N	Scholarship		*OSU Test*	
		High-school	1st-sem. college	Mean	σ
Otis	680	.385	.556	49.24	28.55
Terman	304	.319	.564	50.60	28.12
Henmon-Nelson	258	.477	.569	48.68	25.32
National	48	.399	.621	55.08	26.21
Kuhlmann-Anderson	63	.584	.610	51.69	28.37
Stanford-Binet	91	.482	.584	49.02	28.41
OSU Test (Pre-Entrance)	331	.489	.640	49.46	29.14

This fact offers some suggestion of superiority for the *Henmon-Nelson Test,* although this presumption is not supported by sufficient numbers to make it statistically substantial.

The Mean IQ of the Oberlin Group

Increase in the size of the population studied from 835 to

1,444 represents a change of one point in the mean IQ, or an increase from 121 to 122. The range is 90 to 169, 99 per cent exceeding the general mean of 100. Sigma is 10.7. Comparison with the *Terman-Merrill* sigma, 16.3 (3, p. 37), shows that variability among the Oberlin student-body is much more restricted than it is in the general population. The average IQ for the group who became seniors is the same as for the entire group of freshmen.

Mean College Scholarship of Students at Different IQ Levels

As the number of students who by 1943 had reached senior standing was more than twice the number for whom data were available three years earlier, 577 as compared to 253, a report is again made of first- and seven-semester scholarship of students at different IQ levels (Table 3). The table

TABLE 3

Freshman and Senior Scholarship of Students at Different IQ Levels

	1st-semester college grades				7-semester college grades				
IQ	N	%	Mean	Range	Possible	Actual	%	Mean	Range
166–170	3	0.2	97.7	97–99	3	2	66.7	96.0	93–99
161–165	1	0.1	48.0	48	0				
156–160	3	0.2	67.3	32–92	0				
151–155	8	0.6	85.4	45–98	2	1	50.0	87.0	87
146–150	21	1.5	70.4	13–98	14	8	57.1	70.0	26–97
141–145	36	2.5	65.8	4–99	16	10	62.5	69.1	12–99
136–140	85	5.9	65.3	4–98	54	42	77.8	67.5	1–99
131–135	117	8.1	59.8	1–99	64	49	76.6	50.2	5–99
126–130	210	14.5	55.6	1–99	126	80	63.5	52.8	1–99
121–125	290	20.1	53.5	1–99	189	123	65.1	52.1	5–99
116–120	294	20.4	44.3	1–99	190	118	62.1	42.2	1–94
111–115	191	13.3	38.9	1–97	129	78	60.5	39.4	2–95
106–110	123	8.4	33.6	1–97	84	44	52.4	32.9	2–69
101–105	46	3.2	37.2	1–98	29	14	48.3	44.4	2–96
96–100	9	0.6	28.0	3–42	9	5	55.6	31.0	26–36
91– 95	6	0.4	26.5	7–69	6	3	50.0	18.3	6–35
– 90	1	0.1	27.0	27	0				
Total	1444	100.0			915	577	63.1		

also shows the range of scholarship at each level, and the proportion of those in college long enough to reach senior status at each level. (Scholarship is indicated by centiles.) The table shows that:

a. Although the general tendency is for those of higher IQ to make the better scholastic records, the range of scholastic performance is remarkably similar at the different levels. Achievement ranges between the lowest and the highest decile at each level from an IQ of 101 to that of 141. One student with an IQ of 105 attained a 96 centile standing as a senior. That the IQ was, however, an inaccurate index of her ability is suggested by the fact that she made a 71 centile score on the *OSU Test*.

b. Of 15 students with IQ's above 150, 12 made exceptionally good records.

c. Sufficient time had elapsed for 15 students whose IQ's are below 101 to become seniors. Eight of these have obtained the A.B., but in only four cases was this achieved in the normal four-year period.

d. Some degree of selective persistence is evidenced by comparing the upper with the lower half of the distribution. Of the 468 with IQ's above 120, 315, or 67.3 per cent, persisted, as compared with 262, or 58.6 per cent, of the 447 below that point. The ratio of the difference in these proportions to the standard error of the difference is 2.74.

Relationship between Aptitude and Achievement at Different Levels of Motivation

It is a matter of common observation that one of the basic reasons why the correlations between scholastic aptitude test scores and scholarship is no higher is that the degree of motivation varies widely from student to student. After comparing several formulas for computing an index of effort, Fei Tsao (1) has proposed the one which follows:

$$FQ = \frac{E}{\text{Predicted } E} \times 100$$

in which "E" is an individual's scholastic grade score, and "Predicted E" is the value of the scholastic score which might be predicted from his aptitude test score when one employs the ordinary regression equation. If a student's grade average equals his predicted average, the value of the FQ is 100, this index representing normal effort; if his achievement is higher

than his predicted achievement, the value of the FQ is more than 100; and vice versa. This formula was used in computing Effort Quotients for the 1,444 population, using the IQ and *OSU Test* scores as independent and comparable bases of calculation, along with the high-school scholarship, for the purpose of predicting first-semester college scholarship, and for the 577 who had become seniors, calculating the FQ from the same two intelligence tests, but now employing first-semester scholarship for predicting scholarship for seven semesters.

Correlations between Aptitude Test Scores and First-Semester Scholarship at Different FQ Levels

Table 4 tabulates for each of the FQ levels the correlation

TABLE 4

Correlations at Different FQ Levels between Aptitude Test Scores and First-Semester Scholarship, when FQ is Computed from High-School Scholarship and (1) IQ, (2) OSU Test Scores.

FQ levels	r using IQ's	Scholarship centile		r using *OSU*	Scholarship centile	
		N	Mean		N	Mean
130 & above	.264	125	61.56	.338	101	51.33
120–129	.438	198	64.39	.610	155	56.68
110–119	.541	252	61.39	.692	304	64.67
100–109	.465	269	49.12	.642	292	50.34
90– 99	.244	223	42.85	.483	199	42.34
80– 89	.373	134	43.51	.549	164	46.77
70– 79	.279	95	28.89	.469	97	29.22
60– 69	.245	75	34.87	.518	51	37.55
Below 60	.145	73	18.97	.385	82	23.05
Total	.358	1444	50.00	.566	1444	50.00

between the aptitude test score and first-semester scholarship, together with the numbers and means, permitting a comparison between the results when two different aptitude indices are used, the IQ and the *OSU Test* scores. The predictive index in this case is computed from high-school scholarship.

These data indicate (1) that as the correlation between the IQ and first-semester grades is considerably lower than the corresponding correlation between scholarship and the *OSU Test* score (.358 as compared with .566) this therefore holds true at the different motivation levels. (2) There is consider-

able contrast between the size of r at the different levels. For the calculations employing the IQ, the range is from .145 to .541; for calculations employing the *OSU Test* score, the range is from .385 to .692. (3) The level where the relationship between test scores and scholarship is closest is 110–119. (4) The level where the students make the highest average grades is not that representing the highest FQ, but is one or two steps below the highest. (5) However, the lowest grades on the average are made by those with the lowest effort indices. (6) It is also at the level of low motivation where the correlation between aptitude and achievement is most out of step.

Correlations between Aptitude Scores and Seven-Semester Scholarship at Different FQ Levels

Table 5 is comparable to Table 4, except that in the calculation of the FQ first-semester college scholarship, rather than high-school scholarship, is used in the prediction formula. Again a comparison is made of the correlations between aptitude test score and achievement (in this instance cumulative grades for seven semesters) at the different FQ levels. (1) the r's again run considerably higher where the computation of FQ is based on the *OSU Test* than when the IQ is employed. (2) The FQ extends over a wider range at both extremes than is the case

TABLE 5

Correlations at Different FQ Levels between Aptitude Test Scores and Seven-Semester Scholarships, when FQ is Computed from 1st-Semester Scholarship and (1) IQ, (2) OSU Test Scores; with Mean Scholarship and Percentage of Persistence

FQ levels	r using IQ's	Scholarship centile		r using *OSU*	Scholarship centile		Percentage persisting
		N	Mean		N	Mean	
170–Over	.592	76	72.61	.477	53	60.03	74
150–169	.618	79	69.93	.630	55	61.86	76
130–149	.601	82	61.84	.763	74	63.61	70
110–129	.645	68	52.12	.716	112	67.38	78
90–109	.661	64	49.56	.633	78	45.37	67
70– 89	.244	64	33.63	.512	75	34.83	60
50– 69	.188	62	25.34	.458	58	27.90	59
30– 49	.005	49	18.56	.262	46	19.85	53
Below 30	.015	33	11.56	.210	26	12.42	27
Total	.322	577	50.00	.494	577	50.00	63

when predicting first-semester grades, reaching from below 30 to over 170. (3) The range of *r*'s at the different motivation levels is even greater than was found in the case of the first-semester grades. Where the IQ is used it extends from .005 to .661, and where the *OSU Test* score is used in computing the FQ, the range is from .210 to .763. (4) The correlation between aptitude and achievement is again closest at a point below the highest level, although it is nearer the upper limit than is true in the case of freshmen. (5) Where the FQ is based upon the IQ there is a perfect positive correlation between degree of motivation and mean cumulative scholarship, but where the FQ is based upon the *OSU Test* score the highest grades were made by those with motivation indices of 110–129. From this high point the grade curve slopes regularly in both directions. (6) By the time the students with the lowest level of motivation reached senior status their grade average was a 12 centile. The literal grade equivalent of a 12 centile average for seven-semester cumulative scholarship is a low "C," whereas the letter equivalent of the 73 centile is "B." (7) Sufficient time had elapsed to make it possible for 915 out of the original freshman population of 1,444 to have become seniors. The last column in Table 5 indicates the proportion at each FQ level that persisted into the senior year—FQ being computed from *OSU Test* scores and first-semester scholarship. The largest proportion of those persisting occurred at the 110–129 level, where the per cent is 78. At the lowest motivation level the elimination is 73 per cent, and at the highest level it is 26 per cent. (The elimination represented by these figures is somewhat higher than normal; 38 men from the most recent classes had left college to enter the armed forces. Their FQs are, however, distributed over the population range in such chance fashion as not to disturb the general averages.) (8) For the total group the correlation between FQ and scholarship for seven semesters is .702, when FQ is computed from IQ, and .559, when FQ is based on *OSU Test* scores.

Relation between FQ and Phi Beta Kappa

For the purpose of discovering the relationship between FQ and the highest level of scholastic attainment, Table 6 was pre-

TABLE 6

Proportions at Decile Levels making Phi Beta Kappa when Students are Grouped according to 1) First-Semester Grades, 2) OSU Test Scores, 3) IQ's, and 4) FQ's (derived from OSU Test Scores and 1st-Semester Scholarship).

Decile levels	1st-semester grades N	PBK N	PBK %	*OSU Test* scores N	PBK N	PBK %	IQ's N	PBK N	PBK %	FQ's N	PBK N	PBK %
91–100	59	41	69	47	31	66	63	22	35	63	6	10
81– 90	79	18	23	52	11	21	65	11	17	65	7	11
71– 80	61	4	7	54	11	20	49	3	6	77	30	39
61– 70	65	1	2	71	5	7	62	16	26	61	15	25
51– 60	57	0	0	50	2	4	54	3	6	65	4	6
41– 50	72			49	1	2	75	4	5	59	2	3
31– 40	62			61			41	1	2	62		
21– 30	56			67	1	1	65	2	3	49		
11– 20	48			61	2	3	57	1	2	51		
1– 10	18			65			46	1	2	25		

pared to show the proportions elected to Phi Beta Kappa at different motivation levels, as compared with the proportions from equivalent decile levels of (1) first-semester scholarship, (2) *OSU Test* scores, and (3) IQ. Phi Beta Kappa election is usually granted to the upper eighth of the class.

Table 6 shows that final scholastic honors can be best predicted from freshman grades, 69 per cent having ranked in the highest tenth of the class as freshmen, whereas the corresponding figure for the *OSU Test* is 66 per cent, and for the IQ, 35 per cent. This might have been anticipated from the fact that the correlation between first-semester scholarship and cumulative seven-semester scholarship (which includes first-semester grades) is .805, whereas the validity coefficient for the *OSU Test* is .559, and for the IQ it is but .322. PBK election was obtained by a few students who ranked as low as the lowest deciles in the test distribution. In terms of FQ, the level contributing the largest proportion to PBK membership is 71–80, from which level 39 per cent were elected. This corresponds approximately to the 127–140 FQ group.

Summary

1. A total of 1,444 IQ scores are available for freshmen and 577 for seniors, these having been derived from the following tests: *Otis, Terman, Henmon-Nelson, National, Kuhlmann-*

Anderson, and *Stanford-Binet.* Each student was tested with the *OSU Psychological Examination.*

2. When the correlation figures are compared with those obtained with the smaller population, concerning whom a report was made in 1941, no significant differences appear.

3. The mean IQ of the Oberlin group is 122, the range: 90–169, and sigma: 10.7. The mean for those who became seniors was also 122.

4. Cumulative scholarship for seven semesters ranges from the lowest to the highest decile at each level from an IQ of 101 to 141, and 8 students achieved the A.B. whose IQ's were below 101, although in half of these cases this required more than eight semesters.

5. Some selective elimination on the basis of IQ is indicated by the fact that 67.3 per cent of those with IQ's above 120 became seniors, as compared with 58.6 per cent of those with IQ's below 121. The comparable figures for the upper and lower half of the *OSU Test* distribution are 68.9 and 57.3 per cent. The FQ is a still better basis for predicting persistence, with 73.6 of the upper half as compared with but 52.5 per cent of the lower half continuing into the senior year.

6. The correlation between aptitude test scores and freshman scholarship ranges from .145 to .541, when FQ is computed from IQ; from .385 to .692, when FQ is computed from *OSU Test* score. When the correlations are made with cumulative seven-semester scholarship, the range is still greater. Where the IQ is used it extends from .005 to .661; where *OSU Test* score is used it ranges from .210 to .763.

7. Although the lowest correlations and lowest scholarship correspond to the lowest FQ's, the highest correlations and highest achievement are found at levels somewhat below the highest FQ's.

8. It is the 127–140 FQ level which contributes the largest proportion of students elected to Phi Beta Kappa.

Conclusions

Data from this study confirm the results obtained in 1941 with a smaller population to the effect that it is possible for

a student with an IQ as low as 91–95 to obtain an A.B. in Oberlin College. The fact that this achievement is apt to require more than the usual number of semesters emphasizes the role of determination and directionality. Analysis of the relationship between motivation and achievement shows, however, that the highest grades are not usually made by those with the highest effort indices, but by those within the 56–85 centile range. Because of the method by which the FQ index is computed, the student with an IQ of 100, who makes average grades, obtains a higher index than the one with an IQ of 170, whose achievement is commensurate with his ability; but the former is much less apt to achieve Phi Beta Kappa distinction. The study also shows that when students with low effort indices are grouped, the aptitude test scores give little or no basis for predicting their scholarship, whereas with an able group, who are well motivated, the correlation may be quite high. In the case of the *OSU Test,* the difference is represented by *r*'s of .210 and .763.

REFERENCES

1. Tsao, Fei. "Is AQ or F Score the Last Word in Determining Individual Effort? *Journal of Educational Psychology,* XXXIV (1943), 513–526.
2. Hartson, L. D. and Sprow, A. J. "The Value of Intelligence Quotients Obtained in Secondary School for Predicting College Scholarship." *Educational and Psychological Measurement* I (1941), 387–398.
3. Terman, L. M. and Merrill, M. A. *Measuring Intelligence.* Boston: Houghton Mifflin Company, 1937.

STATISTICAL INTERPRETATION OF SYMPTOMS ILLUSTRATED WITH A FACTOR ANALYSIS OF PROBLEM CHECK LIST ITEMS

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BEHAVIOR symptoms are often found to occur in conjunction more frequently than can be accounted for by chance. When the behavior symptoms are of the maladjustive sort it is customary to refer to their conjunction as a syndrome. Though belief in such syndromes is supported by clinical observation, this same sort of observation yields the conclusion that many cases of maladjustment cannot be considered typical of any recognized syndrome. Furthermore, observation reveals that it is difficult to specify an invariant conjunction of symptoms by which a syndrome may be defined. Elsewhere (3) it has been suggested that these situations and related problems can best be clarified by a statistical interpretation of symptoms. One statistical conception which is useful is factor analysis.

It is the purpose of this article to illustrate how syndromes may be conceived of in terms of factor analysis. Viewed in this way it will be seen that (1) atypical cases are not inconsistent with the recognition of syndromes, and (2) a syndrome is a "central tendency" concept which cannot be, and is not necessarily defined as, an invariant conjunction of symptoms.

The Mooney *Problem Check List* (4) was given to 205 upper classmen in Illinois State Normal University. This instrument consists of 330 items about which students might worry. In using the instrument the student is asked to underline those items about which he worries. When this has been done, he is further instructed to circle those items about which he is seriously concerned. The ten most frequently underlined items were intercorrelated. This was done with the aid of

computing diagrams (1) which provide an estimate of tetrachoric *r*. To have included more items would have involved cell entries so small as to make estimates grossly inaccurate. A direct centroid solution was made and this was transformed to orthogonal simple structure and to an oblique solution.

The extent to which the ten items were found to intercorrelate is shown in Table 1. Since the reliability of the check

TABLE 1

Intercorrelations among the 10 Most Frequently Underlined Items of the Mooney Problem Check List

	1.*	2.	3.	4.	5.	6.	7.	8.	9.	10.
1.*	..									
2.	.55	..								
3.	.38	.38	..							
4.	.37	.15	.40	..						
5.	.28	.08	.40	.05	..					
6.	.16	.43	.24	.05	.18	..				
7.	.01	.02	.00	.15	.18	.23	..			
8.	.18	.05	.03	.22	.15	.08	.52	..		
9.	.04	.12	.08	.04	.12	.36	.25	.28	..	
10.	.25	.00	.02	.04	.02	.07	.05	.12	.19	..

* The items are as follows:

1. Wondering if I'll be successful in life.
2. Wanting a more pleasing personality.
3. Lack of self-confidence.
4. Afraid to speak up in class discussion.
5. Disliking financial dependence on family.
6. Taking things too seriously.
7. Not enough sleep.
8. Too little chance to read what I like.
9. Not enough time for recreation.
10. Restless at delay in starting life work.

list items is not known, but is probably low, all the intercorrelations are very likely attenuated. The standard error of an *r*, when the true correlation is zero, for an *N* of 205 is .069. Though the data are admittedly fallible, we do not believe that they are so much so as to prevent their use for the illustrative purposes we intend.

Though no negative correlations were obtained, it cannot be assumed that the true relationships are positive, owing to the unreliability of the obtained *r*'s.

The second factor residuals are shown in Table 2.

The *B*-group procedure, recommended by Holzinger and Harman (2, p. 23), did not produce clear-cut groups, but it

TABLE 2

Second Factor Residuals

	1.*	2.	3.	4.	5.	6.	7.	8.	9.	10.
1.*		.096	−.218	.015	−.007	−.112	−.056	.038	−.038	.170
2.	.096		−.034	−.105	−.133	.212	−.071	−.092	.023	−.071
3.	−.218	−.034		.077	.149	.022	−.003	−.046	.063	−.035
4.	.015	−.105	.077		−.118	−.123	.074	.104	−.040	−.017
5.	−.007	−.133	.149	−.118		.003	.055	−.004	−.006	−.046
6.	−.112	.212	.022	−.123	.003		−.027	−.196	.110	−.037
7.	−.056	−.071	−.003	.074	.055	−.027		.134	−.130	−.085
8.	.038	−.092	−.046	.104	−.004	−.196	.134		−.089	−.017
9.	−.038	.023	.063	−.040	−.006	.110	−.130	−.089		.060
10.	.170	−.071	−.035	−.017	−.046	−.037	−.085	−.017	.060	

* Numbers refer to items in footnote to Table 1.

was possible to arrange the items in a rough approximation of two groups. In Table 1 the first five items constitute one group and the last five a second. Since a group is defined as a set of items within a correlation matrix which correlate more with each other than with other items in the matrix, a group may be said to constitute a syndrome. How definitely the items of these groups should be thought of as a syndrome will be developed later after the results of the analysis are given. The fact that the items within a group show correlations with some items not in the group illustrates one reason why syndromes are not always clearly defined. If a greater number of items had been included in the matrix, the items which do not fit well in either of these two groups would probably be found to associate themselves with some of the added ones to constitute a third group or syndrome.

In order to illustrate the applicability of factor analysis to the interpretation of symptom intercorrelations, we turn now to these data. A direct centroid factor solution was obtained. Only two factors seemed to be of sufficient reliability, as judged on the basis of the size of the residuals, to merit consideration. The centroid factors were transformed to orthogonal simple structure, and the result is shown in Table 3.

By comparing the loadings of the items on the two factors, it will be seen that the factor axes pass through or very close to the points representing items three and seven (see Figure 1). In fact, the rotation from the centroid axes to orthogonal

TABLE 3

Orthogonal Simple Structure

Variable*	M_1	M_2	Communality
1.	.797	.101	.645
2.	.552	.142	.325
3.	.750	.001	.563
4.	.431	.118	.200
5.	.335	.197	.151
6.	.290	.405	.248
7.	.002	.633	.401
8.	.101	.610	.382
9.	.022	.601	.361
10.	.073	.213	.050
			3.326
Per cent of total variance	19.0	14.3	33.3

* Numbers refer to items in footnote to Table 1.

simple structure was determined by these two items. This procedure follows Reyburn and Taylor (5), who criticize Thurstone's criteria for obtaining simple structure. It is their contention that hypotheses concerning the probable nature of the factors should be used in determining the rotation, for to do so is just as defensible as to use hypotheses concerning the nature of factors as a basis for selecting items for intercorrelation. In the present instance, our choice was not one of complete freedom, for a meaningful analysis could not have been achieved by any arbitrarily chosen angle of rotation.

Consideration of the factor structure as shown in Table 3 indicates that items one to four are most closely related to the first factor and that items seven, eight, and nine are most closely related to the second factor. Thus one syndrome consists chiefly of confusion or worry about future success in life, a more pleasing personality, lack of self-confidence, and fear of speaking in class discussions. The second syndrome involves worry about lack of sleep, lack of opportunity to do preferred reading, and lack of opportunity to engage in recreation. These two syndromes will be recognized by counselors of college students as representing a sizeable proportion of those who come to their attention. The fact that the ten most frequently underlined items contain these two syndromes is thus in accord with expectation.

The three items, five, six, and ten, which are not so definitely characteristic of the two syndromes, would probably align themselves with other symptoms if the correlation matrix included more items. This is most likely true for items five and ten, since the total variance attributable to these two factors is small. It is of course possible that with a larger correlation matrix the groups here identified might not exist. However, all clinical observation makes this possibility seem unlikely. The magnitude of the loadings would doubtless change, but it seems likely that two such clusters would be found and that it would be possible to pass axes through them without doing violence to the data.

The distribution of the loadings on these two factors suggests the possibility that a bi-factor solution would be the best description of the data. However, since there were but two groups, such a solution was not made. It is doubtful if the solution, had it been made, would have added much to the interpretation, and at any rate the illustrative purpose of this discussion can be achieved without it.

We shall now turn to the question of causal factors. The first syndrome contains one item, namely, worry about lacking self-confidence, which is apparently more basic than the others in that it serves to identify the causal factor at the root of the syndrome. The decision to consider this as the causal factor responsible for the first syndrome comes from psychological knowledge other than that presented in these data. It is an inference based largely on case studies.

Inference from clinical observation is even more necessary if a possible causal factor responsible for the second syndrome is to be identified. Such observation suggests that the second syndrome may result from a lack of integration. Students are notoriously prone to run in all directions at once. A hierarchy of preferences is all too often absent with the result that students complain of not being able to study, read, or engage in recreation to the extent that they would like.

The possibility of correlated factors leads to a consideration of an oblique solution. The correlated factor axes were located so as to pass near item one and through the cluster

formed by items seven, eight, and nine. The angle of separation between these correlated reference vectors represents a correlation of .259. The location of the axes and their relation to the orthogonal reference vectors is shown in Figure 1. The

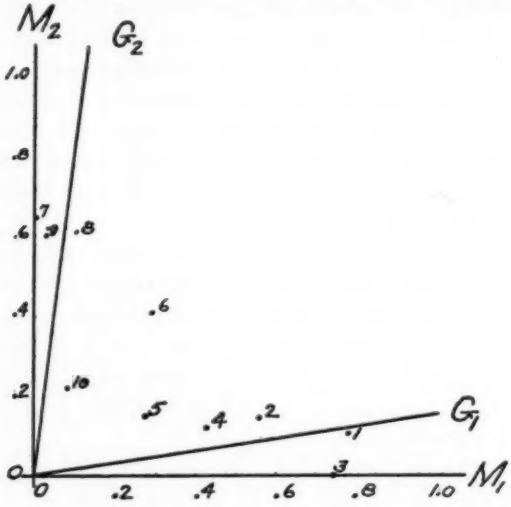

FIGURE 1
Orthogonal and Oblique Reference Vectors

correlated factor structure and pattern are presented in Table 4, while the contribution of the two correlated factors is given in Table 5.

TABLE 4
Correlated Factor Solution

Variable*	Structure		Pattern	
	r_1G_1	r_1G_2	G_1	G_2
1.	.803	.198	.806	−.011
2.	.566	.208	.549	.066
3.	.744	.092	.772	−.107
4.	.443	.169	.428	.058
5.	.360	.236	.320	.153
6.	.344	.438	.248	.374
7.	.090	.629	−.078	.650
8.	.185	.618	.027	.611
9.	.106	.600	−.053	.614
10.	.102	.220	.048	.208

* Numbers refer to items in footnote to Table 1.

The interpretation of the syndromes based upon the oblique solution does not differ greatly from that already discussed in relation to the orthogonal solution. There is, however, the problem of accounting for the correlation between these two correlated factors.

Several plausible bases for such correlation may be suggested. Students doubtless differ in their likelihood of worrying about anything. They may also differ in their willingness to admit worry. Ability to identify the source of their discontent may be another basis for differentiating students. Any one of these factors might be responsible for the correlation between the two vectors. Furthermore, lack of integration may be a factor in producing feelings of inadequacy, and thus the factors would be correlated. While the basis for correlation cannot be identified, there are a number of reasons why it might be expected to exist. In fact, a general factor of adjustment-nonadjustment, and hence correlated factors, are more to be expected than are uncorrelated factors.

TABLE 5

Total Contribution of Correlated Factors

	G_1	G_2
G_1	1.906	.....
G_2	.027	1.397
	Grand Total 3.33	

Now let us suppose that all possible symptoms of maladjustment were intercorrelated and that all unreliability factors were absent. In this hypothetical situation, what might we expect factor analysis to reveal? It seems possible that a relatively small number of factors might be discovered, each representing an axis passing through a cluster of symptoms. These clusters would represent maladjustment syndromes. If symptoms of adjustment were also included in this hypothetical correlation matrix, we may conceive of bi-polar factors as representing the most adequate reference vectors.

Now one of the principal values to be attained by a consideration of symptoms in the statistical framework of factor

analysis is the manner in which it enables us to deal with the typical and atypical cases.

Consider first the orthogonal solution. Suppose that we have an individual with very marked feelings of inferiority or inadequacy, in other words one who "has" a large amount of the first factor. Since the second factor is uncorrelated with it, this individual may have much, none, or very little of the second factor. Assuming the factor loadings shown in Table 2 to be reliable, we would expect such a person to complain of worry about his future and the inadequacy of his personality, to be lacking in self-confidence, and to fear to speak up in class. He would be typical of the first or inferiority syndrome. Another individual might have no inferiority feelings but be greatly lacking in integration. This person would be typical of the second or unorganized syndrome. What is most likely, however, is that relatively more individuals would have moderate amounts of both factors, that is, would feel moderately inferior and be moderately lacking in integration. Such persons would not be typical of either syndrome and would show symptoms present in both. Thus it appears that we might expect that most people would not be "typical" cases. There remains the rare possibility that a given individual, on the basis of probability, would have large amounts of both factors. This person would not be typical either.

In the case of correlated factors the chief difference is that having a large amount of one factor would enhance the probability of having a greater-than-average amount of the other, a circumstance which would make a clear-cut distinction between syndromes even less likely than in the case of uncorrelated factors.

Factor analyses of intercorrelations between most frequently underlined items of the Mooney *Problem Check List* provide data for illustrative purposes. With these data the feasibility and desirability of factor analysis as a framework for clarifying clinical findings can be shown. It is demonstrated that though syndromes may be said to exist, it is not surprising that typical cases representing these syndromes are not more frequently encountered. Though these data deal

with the milder symptoms of maladjustment, the same principles may apply to the interpretation of psychoneuroses and psychoses.

In addition to making the existence of the atypical case consistent with the concept of syndrome, it is also possible to understand why syndromes can scarcely be defined as an invariant conjunction of symptoms. The magnitude of the correlations of the items of either of the syndromes with the factor assumed to be responsible for it is considerably less than perfect. Therefore, even though the basic factor is present we cannot expect that all of the symptoms will be. Various contingencies of the environment may exist without any relation to the existence of the causal factor and may thus alter its manifestation.

Furthermore, it is not inconsistent with the concept of syndrome for one symptom to be present in more than one syndrome; that is, to be moderately correlated with more than one causal factor. Item six, "taking things too seriously," may be an example of such a possibility.

A syndrome must be considered as a central tendency concept rather than an invariant conjunction of symptoms. Syndromes are recognized clinically because individuals with great amounts of the various causal factors do exist. These more dramatic instances are easily recognized. It is not inconsistent with their identification for us to find many other cases which are not typical.

The data also lend support to clinical observations regarding the frequency of certain behavior patterns in students. The evidence is most certainly not conclusive. The statistician will be inclined to doubt its validity and the clinician may feel that such evidence is unnecessary. On this matter we can only endorse Wolfle's (6, p. 40) statement that closer cooperation between clinician and factor analyst is desirable.

REFERENCES

1. Chesire, Leone, Saffir, Milton, and Thurstone, L. L. *Computing Diagrams for the Tetrachoric Correlation Coefficient.* Chicago: Chicago Medical Book Company, 1933.
2. Holzinger, Karl J. and Harman, Harry H. *Factor Analysis.* Chicago: University of Chicago Press, 1941.

3. Marzolf, Stanley S. "Symptom and Syndrome Statistically Interpreted." *Psychological Bulletin,* XLII (1945), 162–176.
4. Mooney, Ross L. *Problem Check List.* Columbus: Bureau of Educational Research, Ohio State University, 1941.
5. Reyburn, H. A., and Taylor, J. G. "On the Interpretation of Common Factors: A Criticism and a Statement." *Psychometrika,* VIII (1943), 53–64.
6. Wolfle, Dael. *Factor Analysis to 1940.* Chicago: University of Chicago Press, 1940.

NEW TESTS OF 1944–1945

California Test of Personality: Primary and Adult Series, by Louis P. Thorpe, Willis W. Clark and Ernest W. Tiegs, 1944. Scores are obtained for two main fields, self-adjustment and social adjustment. Each of these fields is further divided into six areas for which scores are obtained. Tests are in packages of 25, with a manual of directions. Primary series, Form A, per 25 tests, $1.00; Primary series, Form B, per 25 tests, $1.00; 5c per copy for tests when bought in smaller quantities; Primary specimen set, 25c. Adult series, Forms A and B, same prices as for Primary. Published by the California Test Bureau, 5916 Hollywood Blvd., Los Angeles 28, California.

ERC Stenographic Aptitude Test, by Walter L. Deemer, Jr., 1944. Time, 50 minutes. The purpose of this test is to estimate the probable performance of pupils studying shorthand. There are 5 subjects: speed of writing, word discrimination, phonetic spelling, vocabulary, sentence dictation. Package of 25, $3.50; specimen set, 35c. Published by Science Research Associates, 228 S. Wabash Ave., Chicago 4, Illinois.

Foust-Schorling Test of Functional Thinking in Mathematics, by Judson W. Foust and Ralph Schorling, 1945. Time, 45 minutes. This test is intended to measure the power to deal with mathematical relationships. It is usable in the 9th grade and above. Sold only in packages of 25 copies with manual and key at $1.35 per package; specimen set, 15c. Published by World Book Company, Yonkers-on-the-Hudson, N. Y.

General Clerical Test, 1944. Time, 50 minutes. This is a test which has been designed as a general and differential test for use in selecting persons for all types of clerical work. It is for high school and above. Sold in packages of 25 with manual and key. 1–3 packages, $3.25 each; 4–39 packages, $2.85 each; 40 or more packages, $2.60 each. Per copy when package is broken, 15c. Specimen set, 30c. Published by the New York Psychological Corporation, 522 Fifth Ave., New York 18, N. Y.

Goldstein-Scheerer Test of Abstract and Concrete Thinking, by Kurt Goldstein and Martin Scheerer, 1945. These tests are for the use of psychologists, psychiatrists, and neurologists working with patients who have brain injuries. They are designed to measure both quantitatively and qualitatively the impairment of the function of the brain with reference to abstract and concrete reasoning. The monograph contains full instructions for the administration and interpretation of the tests. Three of the five tests are available: the *Goldstein-Scheerer Cube Test,* the *Weigl-Goldstein-Scheerer Color-Form Sorting Test,* and the *Goldstein-Scheerer Stick Test. Cube Test:* 2 design books, $4.75 per set; Kohs blocks, $1.00 per set of 12; record forms, sold only in packages of 50, $2.75. *Stick Test:* 30 plastic sticks of 4 lengths, $2.00 per set; record forms, including mimeographed supplement to the monograph, sold only in packages of 50, $2.75. Complete materials, all three tests, including a copy of the monograph, "Abstract and Concrete Behaviour," $21.50. Published by the Psychological Corporation, 522 Fifth Avenue, New York 18, N. Y.

How Supervise? by Quentin W. File. No time limit. Norms are given in percentile rank and standardized scores. This test is considered as a measuring instrument of the supervisors' knowledge and insight concerning human relations in in-

dustry. It is designed to aid management in obtaining a clearer picture of its supervisors' understanding of the more important general aspects of the job. There are 3 sections: Supervisory Practices, Company Policies, and Supervisor Opinions. Forms A and B. Sold in packages of 25 with manual and key. 1 to 3 packages, $2.00 each; 4 to 39, $1.65 each; 40 or more, $1.50 each; single copies, 10c. Specimen set, 30c. Published by the Psychological Corporation, 522 Fifth Avenue, New York 18, N. Y.

Inventory of Factors GAMIN (Abridged Edition), by J. P. Guilford and H. G. Martin. This test is designed to measure the following personality characteristics: G, general pressure for overt activity; A, ascendency in social situations as opposed to submissiveness; M, masculinity of attitudes and interests as opposed to femininity; I, lack of inferiority feelings; and N, lack of nervous tenseness and irritability. Supplement to the manual and scoring keys are to be printed shortly, 100 copies, $10.00; 50 copies, $6.00; specimen set without scoring keys, 25c; specimen set with scoring keys, 50c. Published by the Sheridan Supply Company, P.O. Box 837, Beverly Hills, California.

Johnson Temperament Analysis, by Roswell H. Johnson, 1944. The form is self-administering and ordinarily requires 40 to 50 minutes. The following scores are obtained: nervous, depressive, active, cordial, sympathic, subjective, aggressive, critical, and self-mastery. Specimen sets include: test booklet, manual of directions, response record sheet, and 1 analysis profile sheet. Scoring stencils must be ordered separately. The price of the specimen set is 25c postpaid. Per 25 tests, $1.25; 10c each in smaller quantities. Response record sheets, 1½c each; analysis profiles, 1c each. Published by the California Test Bureau, 5916 Hollywood Blvd., Los Angeles 28, California.

Mellenbruch Aptitude Test for Men and Women, by Paul L. Mellenbruch, 1944. Time, 35 minutes. This test is designed to discover the degree and limits of the mechanical trainability of men and women applicants for mechanical positions. It is also intended as a counseling aid for selecting junior and senior high school students who will profit from industrial arts training. Scoring key is included free with each order of 25 or more booklets. Published by Science Research Associates, 228 Wabash Ave., Chicago 4, Illinois.

Minnesota Multiphasic Personality Inventory, Group Form, by Starke R. Hathaway and J. Charnley McKinley. Time required is from 30 to 90 minutes. The individual form, published earlier, has been adapted to group form for use with those not requiring individual attention. For subjects from about 16 years of age upward. The following scores are obtained: hypochondriasis, depression, hysteria, psychopathic deviate, paranoia, masculinity, hypomania, validity, tendency to lie and tendency to give "cannot say" replies. Booklets may be reused. 1–24 booklets, 25c each; 25 or more, 22c each. Keys (either hand-scoring or machine-scoring should be specified) and manual, $7.50. I.B.M. answer sheets, $5.00 per 100; 6c each in smaller quantities. Published by the Psychological Corporation, 522 Fifth Avenue, New York 18, N. Y.

Occupational Interest Inventory—Intermediate, Form A, devised by Edwin A. Lee and Louis P. Thorpe, 1944. For junior high-school students to adults. The following scores are obtained: personal-social, natural, mechanical, business, the arts, the sciences, verbal, manipulative, computational, and interest level. Package of 25 tests with manual, $1.75; 8c each in smaller quantities; specimen set, 25c. Published by the California Test Bureau, 5916 Hollywood Blvd., Los Angeles 28, California.

Occupational Preference Inventory, by Paul P. and Ralph T. Brainard, 1945. No time limit. This blank replaces the *Brainard and Stewart Specific Interest Inventories*, which will go out of print shortly. Occupational preferences are divided into 28 occupational sections, and the 28 sections are combined into 7 major occupational fields: commercial, personal service, agriculture, mechanical,

professional, esthetic and scientific. Booklets can be reused. Inventory booklets with manual: 1 to 9 copies, 25c each; 10 to 99, 22c each; 100 or more, 20c each: Manual is 25c extra when fewer than 10 are ordered; record forms are sold only in packages of 50. 1 package is $3.75; from 2 to 19, $3.50 each; 20 or more, $3.00 each; per copy, 10c each. Specimen set is 50c. Published by the Psychological Corporation, 522 Fifth Avenue, New York 18, N. Y.

Personal Audit (Revised), Forms LL and SS, by Clifford R. Adams, 1945. No time limits. Form LL consists of 9 parts, each part containing 50 items. This form can be used with adults having the equivalent of a grammar school education or with senior high school students. The first six parts of Form LL are published separately as Form SS. Form SS is recommended for use with junior high school students or in other situations where testing time must be curtailed. Scoring requires no keys. The fields for which scores are obtained are: seriousness-impulsiveness, tranquility-irritability, frankness-evasion, stability-instability, tolerance-intolerance, steadiness-emotionality, persistence-fluctuation, contentment-worry. Form LL: package of 25 tests with manual, $3.75; specimen set, 35c. Form SS: package of 25 tests with manual, $2.50; specimen set, 25c. Published by Science Research Associates, 228 S. Wabash Ave., Chicago 4, Illinois.

Pintner General Ability Tests: Non-Language Series, by Rudolph Pintner, 1945. These group tests are designed to measure mental functions independently of word knowledge and facility, and may even be administered in pantomime without the use of language, using special directions which can be obtained on request. The series is to consist of two batteries: the Intermediate Test for grades 4 through 9, and the Advanced Test for grades 9 and above. The Intermediate Test is now available. Package of 25 tests with manual, $1.80; specimen set, 30c. Published by the World Book Company, Yonkers-on-the-Hudson, New York.

P–L–S Journalism Test, by George H. Phillips, Harry Levinson and H. E. Schrammel, 1944. Time, 40 minutes. This test is designed for use in high school and college classes which have completed a first course in journalism. Percentile norms are given. Per package of 25, directions and key included, $1.00 f.o.b. Emporia; $1.15 postpaid. In quantities less than 25, test 5c, directions 5c, specimen set, 15c. Published and distributed by the Bureau of Educational Measurements, Kansas State Teachers College, Emporia, Kansas.

Reading Achievement Test—Intermediate Test: Forms A and B, by Donald D. Durrell and Helen Blair Sullivan, 1944. Time, 30 to 45 minutes. These forms of the *Reading Achievement Test* are designed for grades 3 to 6. Sold only in packages of 25 with manual and key. Form A or B, $1.55. Specimen set, 55c. Published by the World Book Company, Yonkers-on-the-Hudson, New York.

Schrammel-Otterstrom Arithmetic Test, by H. E. Schrammel and Ruth Otterstrom, 1945. Time, 50 minutes. This test consists of two divisions: Test II for grades 4, 5, and 6; and Test II, for grades 7 and 8. Percentile norms are provided for interpreting the scores for each part and for the entire test, both mid-year and end-of-year testing. Per package of 25, directions and key included, 60c f.o.b. Emporia; 75c postpaid. In quantities less than 25; test 3c, key 3c, directions 5c. Specimen set, 20c. postpaid. Published and distributed by the Bureau of Educational Measurements, Kansas State Teachers College, Emporia, Kansas.

Stevens Reading Readiness Test, by Avis Coultas Stevens, 1944. These tests assist the teacher to group her beginning children for reading. They are not intended to displace intelligence or kindergarten tests. Package of 25 tests with manual and key, $1.80; specimen set, 20c. Published by the World Book Company, Yonkers-on-the-Hudson, New York.

Survey of Mechanical Insight, designed by D. R. Miller, 1945. Time, 25 minutes. Designed to measure aptitude for solving the types of problems involved in jobs

requiring the operation, maintenance, repair, or design of various types of machinery. Package of 25 tests with manual and key, $2.50; 11c each in smaller quantities. Published by the California Test Bureau, 5916 Hollywood Blvd., Los Angeles 28, California.

Survey of Object Visualization, by D. R. Miller, 1945. Time, 20 minutes. This survey requires the examinee to predict how an object will look when its shape and position are changed. Tentative percentile norms are given. The test is practically self-administering and the scoring is completely objective. Package of 25 tests, including a manual of directions and scoring key, $1.50; 7c a copy in smaller quantities. Published by the California Test Bureau, 5916 Hollywood Blvd., Los Angeles 28, California.

Survey of Space Relations Ability, by Harry W. Case and Floyd Ruch, 1944. Time, 15 minutes. This test is designed to measure the ability of the employee or applicant to perceive rapidly and accurately the relationships among objects in space. Tentative percentile norms are furnished. Package of 25 tests, including a manual of directions and scoring key, $2.00; specimen set, 25c. Published by the California Test Bureau, 5916 Hollywood Blvd., Los Angeles 28, California.

Wechsler Memory Scale, by David Wechsler, 1945. This a short individual test of memory arranged for use by psychologists working in mental hospitals. Sold only in packages of 50 record forms, with a set of cards for one of the tests, $1.90; manual must be ordered separately, 45c; specimen set, including manual, design card and record form, 70c. Published by the Psychological Corporation, 522 Fifth Avenue, New York 18, N. Y.

Wellesley Spelling Scale, by Thelma G. Alper and Edith B. Mallory, 1944. This spelling ability test is for use at high school and college levels. Percentile norms are provided for the various grades from nine to college freshmen. Forms I and II, per 25 tests, 75c each; in smaller quantities, 4c per test. Published by the California Test Bureau, 5916 Hollywood Blvd., Los Angeles 28, California.

The United States Armed Forces Institute Tests of General Educational Development, 1945. The purpose of these tests is to measure the extent to which all of the past educational experiences of the individual tested have contributed to his general educational development or to his ability to carry on an educational program in high school or in the first two years of college. Emphasis is placed on intellectual powers rather than detailed content. Cost of the tests may be had upon application to the distributors. Published by the American Council on Education. Distributed by the Cooperative Test Service of the American Council on Education, 15 Amsterdam Ave., New York 23, N. Y., and Science Research Associates, 228 S. Wabash Ave., Chicago 4, Illinois.

High School Level Tests. These tests are to determine whether the individual has had the equivalent of a high school education. Standard scores are provided; percentile norms for the total score are available. The tests include:

Test 1. *Correctness and Effectiveness of Expression.*
Test 2. *Interpretation of Reading Materials in the Social Studies.*
Test 3. *Interpretation of Reading Materials in the Natural Sciences.*
Test 4. *Interpretation of Literary Materials.*
Test 5. *General Mathematical Ability.*

College Level Tests. These tests are to determine whether the individual is capable of carrying on advanced college work. Standard scores are provided; percentile norms are available. The tests include:

Test 1. *Correctness and Effectiveness of Expression.*
Test 2. *Interpretation of Reading Materials in the Social Studies.*
Test 3. *Interpretation of Reading Materials in the Natural Sciences.*
Test 4. *Interpretation of Literary Materials.*

Subject Tests. These tests are to determine the individual's proficiency in specific subjects on both high school and college levels. The tests include:

Examination in English—High School Level; Book I: Reading and Interpretation of Literature and Literary Acquaintance. Percentile norms for total score available for grades 10, 11 and 12.

Examination in English—High School Level; Book II: Composition. Norms are available.

Examination in English—College Level; Book I: Reading and Literary Acquaintance. Percentile norms for total score are available.

Examination in English—College Level; Book II: Composition. Percentile norms are available.

Examination in Business English—High School Level. No norms available.

Examination in Commercial Correspondence—College Level. No norms available.

Examination in French Vocabulary—Lower Level. No norms available.

Examination in French Reading Comprehension—Lower Level. No norms available.

Examination in French Grammar—Lower Level. No norms available.

Examination in French Vocabulary—Upper Level. No norms available.

Examination in French Reading Comprehension—Upper Level. No norms available.

Examination in French Grammar—Upper Level. No norms available.

Examination in German Vocabulary—Lower Level. No norms available.

Examination in German Reading Comprehension—Lower Level. No norms available.

Examination in Spanish Vocabulary—Lower Level. No norms available.

Examination in Spanish Reading Comprehension—Lower Level.—No norms available.

Examination in Spanish Grammar. No norms available.

Examination in Italian Vocabulary. No norms available.

Examination in Italian Reading Comprehension—Lower Level. No norms available.

Examination in Italian Grammar—Lower Level. No norms available.

Examination in Business Arithmetic—High School Level. No norms available.

Examination in Advanced Arithmetic—High School Level. No norms available.

Examination in Elementary Algebra—High School Level. Percentile norms for total score available.

Examination in Second-year Algebra—High School Level. Percentile norms for total score available.

Examination in Plane Geometry—High School Level. Percentile norms for total score available.

Examination in Algebra—College Level. No norms available.

Examination in Plane Trigonometry—College Level. No norms available.

Examination in Analytic Geometry—College Level. No norms available.

Examination in General Science—High School Level. No norms available.

Examination in Biology—High School Level. No norms available.

Examination in Physics—High School Level. No norms available.

Examination in Chemistry—High School Level. Percentile norms for total score available.

Examination in Meteorology—High School Level. No norms available.

Examination in Senior Science—High School Level. No norms available.

Examination in Chemistry—College Level. Percentile norms for total score available.

Chemistry Examination in Qualitative Analysis. No scaled scores provided. Percentile norms available.

Chemistry Examination in Quantitative Analysis. Percentile norms available.

Examination in Organic Chemistry. Percentile norms available.

Examination in Astronomy—College Level. No norms available.

Examination in Elementary Psychology—College Level. No norms available.

Examination in American History—High School and College Levels. Percentile norms available.

Examination in World History—High School Level. No norms available.
Examination in Civics—High School Level. No norms available.
Examination in Problems of Democracy—High School Level. No norms available.
Examination in German Grammar—Lower Level. No norms available.
Examination in Business English—High School Level. No norms available.
Examination in Commercial Correspondence—College Level. No norms available.
Examination in Business Arithmetic—High School Level. Percentile norms available.
Examination in Gregg Shorthand—First Year—Secondary School. No norms available.
Examination in Typewriting—First Year—Secondary School. No norms available.
Examination in Typewriting—Second Year—Secondary School. No norms available.
Examination in Bookkeeping and Accounting—First Year—Secondary School. No norms available.
Examination in Bookkeeping and Accounting—Second Year—Secondary School. No norms available.
Examination in Mechanical Drawing—High School Level. No norms available.
Examination in Engineering Drawing—College Level. No norms available.
Examination in Machine Design—College Level. No norms available.
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MEASUREMENT ABSTRACTS*

Achard, F. H. and Clarke, Florence H. "You *Can* Measure the Probability of Success as a Supervisor." *Personnel,* XXI (1945), 353–373.

The authors studied 300 successful and indifferent supervisors in a public utility. They developed a supervisory rating scale which they found to be quite accurate and reliable for the four groups of supervisors studied. Successful supervisors had higher scores in tests of mental ability, personality and breadth of interest, and in ability to see and understand quickly (visual perception). The procedure proposed by the authors for the selection of supervisors includes: the selection of tests, the selection of candidates, sifting out of candidates on the basis of test scores, and final selection by executives, adding to ratings based on test scores (a) job knowledge, (b) versatility and adaptability, (c) mental, physical, and emotional fitness, (d) standing with colleagues, and (e) how well they "click" with prospective superiors. *Elizabeth Bell.*

Allen, Mildred. "Relationship Between the Indices of Intelligence Derived from the Kuhlmann-Anderson Intelligence Tests for Grade I and the Same Tests for Grade IV." *Journal of Educational Psychology,* XXXVI (1945), 252–256.

The *Kuhlmann-Anderson Intelligence Tests* for Grade I were administered to 300 school children in the middle of their first year. Near the beginning of their fourth grade they were given the same test for that level. Neither M.A., I.Q., nor Pc. Av. obtained at Grade IV were adequately predicted from the same scores in Grade I. The author believes the low relationship might be due to the differences in verbal content between the two tests (the first grade is all non-verbal) and that the results question the validity of long-range predictions from a group intelligence test at the non-verbal grade level. She concluded that a verbal group intelligence test has greater validity for predicting successful achievement in the tool subjects when given with an achievement test. This would also assist "in determining whether pupils are working up to their ability." *Elizabeth Bell.*

Altus, William D. "Racial and Bi-Lingual Group Differences in Predictability and in Mean Aptitude Test Scores in an Army Special Training Center." *Psychological Bulletin,* XLII (1945), 310–320.

The dichotomous disposition of four bi-lingual groups, American Indian, Mexican, Filipino, and Chinese, permitted validating testing devices by the bi-serial correlation method. The highest average bi-serial correlations between four verbal subtests of the *Wechsler Mental Ability Scale,* Form B, and discharge versus graduation, were found in the Negro group, including three in the .50's. The Indian was next, and the Mexican lowest. The Filipino would have been second in average validity but for a low arithmetic subtest correlation. Verbal tests gave lower scores to the bi-lingual groups, but did not lose in validity. In mean test scores whites were definitely superior, Negroes were second, and Mexicans third. There was little difference between Chinese and Filipino, while the Indian was significantly lowest. The data prove nothing as to innate racial differences because of divergent backgrounds. *Elizabeth Bell.*

Glick, H. N., Flynn, Elizabeth, and Macomber, Lois. "Some Comparisons Between the Original and the Revised Stanford-Binet Scales." *Journal of Educational Psychology,* XXXVI (1945), 177–183.

This article presents results of two studies conducted at Massachusetts State College with respect to certain comparisons between the original and revised *Stan-*

* Edited by Forrest A. Kingsbury.

ford-Binet scales. The most significant finding was that the two scales measured practically the same thing. The new scale was found to be more valid as a measure of intelligence in testing slightly superior children. Also it was found that the new scale tested slightly higher and showed greater dispersion of I.Q.'s than the old. *Jane Nathler.*

Goldfarb, William. "Note on a Revised Block Design Test as a Measure of Abstract Performance." *Journal of Educational Psychology,* XXXVI (1945), 247–251.

The *Revised Block Design Test* is an adaptation of the *Wechsler Block Design Test.* The adaptation involved two changes. The first was an extension of the time limit to five minutes for each card. The second was the introduction of a new scoring method whereby the subject received anywhere from zero to three credits per picture depending on the degree of accuracy. The test, consisting of seven designs, was administered to thirty adolescents with a mean age of 12.3. Each child was rated on the *Revised Block Design Test,* the *Wechsler Block Design Test,* the *Wechsler Similarities Test,* the *Vigotsky Test,* and the *Weigl Test.* All correlations were significant at the one per cent level. The correlation between the block design tests was .90. Both block tests offer a good measure of the ability to generalize. The *Revised Block Design Test* has a slightly higher correlation with other criteria of abstract ability. *Betty Steele.*

Lewis, W. Drayton. "The Relative Intellectual Achievement of Mentally Gifted and Retarded Children." *Journal of Experimental Education,* XIII (1944), 98–109.

The purpose of the investigation was to determine the degree of relative achievement of mentally retarded and mentally gifted children. The subjects consisted of children from four hundred and fifty-five schools from thirty-six states. The *Kuhlmann-Anderson* and the *Unit Scales of Attainment Tests* were given to twelve hundred subjects for each grade. Reading, geography, arithmetic, and language tests were selected from a battery of eleven tests. The basic assumption was that if either group were working up to capacity, the median achievement scores should diverge as much from the norms as do the median mental ages. The results show that the superior group fails to achieve expectations, whereas the retarded group achieves more than expectations. The author concludes that relative achievement, based solely on mental age placements, is not significant. The important factors may be chronological age and length of attendance in school. *Betty Steele.*

London, Ivan D. "Psychology and Heisenberg's Principle of Indeterminacy." *Psychological Review,* LII (1945), 162–168.

The purpose of this article is to demonstrate that Heisenberg's principle of indeterminacy is inapplicable for psychology. Statisticians in psychology are not justified in presenting this principle as a sufficient reason for the inability to eliminate or evaluate interference. The principle results from the attempt to extrapolate into the microcosm the same dual concepts of space and time attributed to macrocosmic events. The principle applies only to the sub-atomic world. Interferences in psychological situations are the results of methodological difficulties inherent in the situation and not because of Heisenberg's principle. There are two types of phenomena in psychology: (1) Convergent phenomena in which behavior is determined from the average behavior of its parts; (2) Divergent phenomena in which a single discontinuous event affects the whole aggregate. In the latter phenomena the indeterminacy deriving from the unpredictable behavior of a single electron deals with isolated and unique electrons which cannot be duplicated. Such indeterminacy cannot be made the basis of a systematic psychology. *Betty Steele.*

Montagu, M. F. Ashley. "Intelligence of Northern Negroes and Southern Whites in the First World War." *American Journal of Psychology,* LVIII (1945), 161–188.

Scores made on the intelligence tests administered by the U. S. Army to Negro and white draftees during World War I are analyzed and discussed. Whites in any given state scored higher than Negroes in the same state on all tests and in all states

except Kentucky and Ohio, where the Negroes excelled on the *Beta* tests. However, it was also found that the median score made by Negroes in a number of states was better than that made by whites in several other states. The conclusion, supported by geographical evidence, is drawn that the lower scores of the whites, in the instances where they appear, are due to inferior socio-economic conditions, and the generally lower scores of the Negroes are similarly explained. Findings indicate that differences in performance on the tests between Negroes and whites are due solely to the action upon native endowment of differences in socio-economic history. *Frances E. Smith.*

Munroe, Ruth. "Three Diagnostic Methods Applied to Sally." *Journal of Abnormal and Social Psychology,* XL (1945), 215–227.

Sally is the fictitious name applied to a normal, fairly well adjusted, Sarah Lawrence College-student, one of a group of eleven who were selected for an intensive study to determine with what accuracy certain testing procedures could portray the wholeness of personality and educative potentialities of the students. The *Rorschach* test, modified for large-scale use, was administered by Munroe, a graphological analysis was effected by Lewinson, and Waehmer made an appraisal from spontaneous drawings. These findings were augmented by reports from the faculty adviser and instructors. The experimenters and teachers worked blindly and independently of each other. There was a sufficient degree of conformity between the reports, the analysis of the tests, and the accomplishments of the students to suggest that remedial methods indicated by the tests might have been of value. *Helen Heath.*

Patterson, R. Melcher. "Evaluation of a Prolonged Pre-Academic Program for High Grade Mentally Deficient Children in Terms of Subsequent Progress." *Journal of Experimental Education,* XIII (1944), 86–89.

The Prolonged Pre-Academic Program is an experimental educational unit at the Wayne County Training School. On the basis of experimental data it was found that mentally deficient children of I.Q. levels 60–79 inclusive, educated on the time schedule described, appeared to progress in academic work when it was introduced at a rate which enabled them to arrive at approximately the same average grade level by 16 years of age as they would have achieved had academic instruction started at the earliest possible mental age and been given continuously. *Jane Nathler.*

Rabin, Albert I. "Psychometric Trends in Senility and Psychoses of the Senium." *Journal of General Psychology,* XXXII (1945), 149–162.

The *Wechsler-Bellevue* intelligence scale was administered to 150 individuals aged 60–84, admitted to the New Hampshire State Hospital, and 100 of the resulting records were divided into 4 diagnostic groups: Senile, C.A.S., Miscellaneous (not including organic), and Non-Psychotic. Analysis of results showed no intra-test organizational or structural differences between classes. Large positive deviations occurred in the 3 major verbal subtests, while practically all performance subtests showed negative deviations. When scores of each subject were correlated with age, only performance subtests showed statistically significant negative correlations, though *r*'s for verbal subtests were also negative. Changes occurring in performance and timed subtests appear to be due to age levels rather than differential diagnosis, with inflexibility and perseverative tendency as the significant factors in lowered performance. Findings of this investigation fail to agree with Wechsler's dichotomy of tests which "do not hold up with age," and do not support the statement that schizophrenia resembles "premature aging." *Frances E. Smith.*

Ryan, Thomas Arthur. "Merit Rating Criticized." *Personnel Journal,* XXIV (1945), 6–15.

The author suggests the use of his *Inventory of Personnel* as a simpler procedure based on "few doubtful assumptions" than the merit rating, until new and different methods for evaluating personnel are produced through research. He criticizes the graphic rating scale of today as being based on false logic, since it secures ratings on distinct traits, then assigns a total score ("adding apples and carts"), thus substituting one trait for another. Also, there is no known way of

validating the weights given traits. The halo effect he believes so strong that a single careful rating of a man's "over-all value" is probably better. Ratings cannot be compared or corrected for constant errors with confidence. He also states that studies have shown their reliability to be generally low. *Elizabeth Bell.*

Sargent, Helen. "Projective Methods: Their Origins, Theory, and Application in Personality Research." *Psychological Bulletin,* XLII (1945), 257–293.

The theoretical and historical background of the projective methods is presented, and the methods are discussed with regard to their application, under the classifications of materials, functional uses, techniques, and purposes. Fundamental experiments testing the efficacy of the methods have been few, and there is need for further research bearing on underlying assumptions and predictive value. Experiments thus far conducted demonstrate the basic mechanism of projection and claim some degree of predictive success for projective methods. Methodological problems include questions of reliability, validity, and standardization. Evaluation of the methods stresses the importance of an open-minded attitude toward theory revision and innovations in method. Projective methods hold promise in clinical psychology for a science of diagnosis and treatment; there is considerable evidence that they are worth thorough exploration. The bibliography contains 274 references. *Frances E. Smith.*

Smith, Francis F. "The Use of Previous Record in Estimating College Success." *Journal of Educational Psychology,* XXXVI (1945), 167–175.

The purpose of the investigation was to predict, on the basis of high-school records, the number of grade-point scores each freshman would earn in his first semester in college. The high-school record, based on about eighty examinations evaluated by sixteen instructors at different times, was converted into one figure indicating the percentage of recommended grades. A multiple-prediction formula was used which included the freshman's aptitude percentile, reading percentile, and English A percentile. The subjects were 903 freshman students. The standard error of estimate from the multiple-prediction formula was 7.97. The results show a correlation of .60 between the high-school record based on a single figure and actual success in the first semester in college. However, the score loses its predictive value after a year or more. It was found that the best indicator of future scholastic success was the previous semester's record. *Betty Steele.*

Swift, Joan W. "Reliability of Rorschach Scoring Categories with Pre-School Children." *Child Development,* XV (1944), 207–216.

Reliability for Rorschach scoring categories was tested with pre-school children as subjects under the following conditions: (1) Test-retest over a 30-day interval. Reliabilities ranged from +.15 to +.83. (2) Test-retest over a 14-day interval with a second series of ink blots interpolated on the 7th day. Uncorrected *r*'s ranged from +.41 to +.74, and corrected values for scores obtained by combining test and retest from +.59 to +.84. (3) Use of a parallel series of ink blots over a 7-day interval, with subjects identical with those used in (2). The *r*'s ranged from −.06 to +.84, all but one being above +.39, while corrected values for scores obtained by combining the 2 series of cards ranged from −.08 to +.86. (4) Test-retest over a ten-month interval, with 20 subjects retested as part of (2) ten months after participation in (1). Range of *r*'s was from +.18 to +.53. Reliability was affected by small number of responses given by each child, low frequency of occurrence of many response categories, and variability of interest and attention span of the children. *Frances E. Smith.*

Swift, Joan W. "Matchings of Teachers' Description and Rorschach Analyses of Pre-School Children." *Child Development,* XV (1944), 217–224.

Investigation was made of the validity of the total personality picture given by the *Rorschach* method when applied to pre-school children. Validating material consisted of a 250-word personality sketch of each of 30 pre-school children, written by the children's teachers. Of the thirty matchings, 14 were correct and 16 incorrect, a result found to be significantly better than chance at the 1 per cent level of confi-

dence. All but 3 of the 14 correct matchings were of boys, a result possibly due to sex differences in stereotypy of behavior. *Frances E. Smith.*

Wells, F. L. "Mental Factors in Adjustment to Higher Education." *Journal of Consulting Psychology,* IX (1945), 267–286.

"An introduction to the psychometric work of the Grant Study, concerned with well-adjusted Harvard undergraduates," with reference to the "technical problems in the measurement of the superior intellect, . . . career choice, as well as educational prognosis." It is concluded that the abstraction of the liberal arts college curriculum is not the real problem, but the fact that it is offered to many who probably cannot assimilate it. "A more highly ideational type of mind than commonly receives it" profits most from it. One half of the present college population could be replaced from the ranks of those economically not so fortunate. Two broad mental qualities are needed for college scholastic success, absorptiveness and creativity. The latter is hard to recognize with our present methods of measurement. For this reason, objective tests are believed inadequate for higher education. Eight case studies of well-adjusted students are presented. *Elizabeth Bell.*

Woodrow, Herbert. "Intelligence and Improvement in School Subjects." *Journal of Educational Psychology,* XXXVI (1945), 155–166.

Studies were conducted at Litchfield, Ill., and Providence, R. I., to determine whether improvement is synonymous with intelligence and whether there is any common factor in improvement. In the Litchfield study, the *Metropolitan Achievement Battery* and the *Otis Quick-Scoring Mental Ability Tests* were given to fourth-, fifth-, and sixth-grade children in May of successive years. Intercorrelations of gains in six school subjects were .12. Factor analyses revealed no gain factor common to the six subjects. Three factors were found: 1) an intelligence factor determining the I.Q., but not the gain; 2) an arithmetic factor; 3) a reading and English factor. In the Providence study the *Stanford Achievement Test* was used. The differences in standard scores for periods of one, two, and three years revealed low gain correlations. Three factors were found which were similar to those found in the Litchfield study. The conclusion of both studies is that there is no general gain factor, and that there is no significant relation between change in score and I.Q. *Bette Steele.*